

Final Report

**RISK ASSESSMENT
TECHNICAL REPORT
(VOLUME II)**

**NAVAL EDUCATION AND TRAINING CENTER
NEWPORT, RHODE ISLAND**

Contract No. N62472-86-C-1282
January 1992

Prepared for:

**Northern Division
Naval Facilities Engineering Command
Lester, Pennsylvania**

TRC
TRC Environmental Corporation

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**RISK ASSESSMENT
APPENDICES
(VOLUME II)**

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EXECUTIVE SUMMARY

A Remedial Investigation (RI) was conducted at the U.S. Navy Naval Education and Training Center (NETC) located in Newport, Rhode Island by TRC Environmental Consultants, Inc. (TRC). The RI was conducted by TRC under contract with the United States Navy, as part of the Department of Defense Installation Restoration (IR) Program, which is similar to the U.S. EPA's Superfund program. The NETC facility is currently listed on the U.S. EPA National Priorities List (NPL).

The Phase I Remedial Investigation Report presents the results of Phase I field activities conducted at five sites within the NETC facility, as well as the results of Human Health Evaluations conducted for the sites. The sites which were studied include the following:

- McAllister Point Landfill (Site 01);
- Melville North Landfill (Site 02);
- Old Fire Fighting Training Area (Site 09);
- Tank Farm Four (Site 12); and
- Tank Farm Five (Site 13).

This volume of the report, Volume II, presents the results of the Human Health Evaluation, describing the chemicals of potential concern, assessing potential exposure pathways and chemical toxicity, and characterizing risks associated with each site. The sites' histories, physical characteristics of the sites, the activities conducted during the Remedial Investigation, and the nature and extent of contamination at and around each site are addressed in Volume I of the report.

This Executive Summary presents an overview of the purpose and methodology of risk assessment activities, followed by a site-by-site description of the study and its results.

PURPOSE AND METHODOLOGY

The primary objectives of the Human Health Evaluation conducted at the NETC include the following:

- Examine exposure pathways and contaminant concentrations in environmental media at each site;
- Estimate the potential for adverse effects associated with the contaminants of concern at each site under current and future land use conditions;
- Provide a risk management framework upon which decisions can be made regarding what, if anything, should be done at a site;
- Identify site or land use conditions that present unacceptable risks; and
- Provide a basis from which recommendations for future activities at the site can be made which are protective of human health.

METHODOLOGY

The risk assessment follows guidelines established by the U.S. Environmental Protection Agency in the Interim Final Risk Assessment Guidance for Superfund, Volume I (Human Health Evaluation Manual - Part A) (1989) and Supplemental Risk Assessment Guidance for the Superfund Program, Part 1 - Guidance for Public Health Risk Assessments (1989). The general format followed in conducting each individual site risk assessment is presented below, followed by site-specific descriptions of risk assessment findings.

Chemicals of Potential Concern - For each site, potential contaminants of concern have been evaluated and identified for the various media identified at the site. For each medium, the analytical data were evaluated following EPA guidelines (EPA, 1989). The chemicals of concern were identified on the basis of this evaluation, and a determination was made as to which chemicals would be addressed qualitatively and/or quantitatively in the risk assessment. In some cases, data qualified with U, J or UJ qualifiers (i.e., not verified "hits") were used in the quantitative risk assessment, in accordance with current guidance, and these compounds drove the risk assessment. These cases are noted where applicable.

Exposure Assessment - The exposure assessment involved considerations of potential receptor populations and migration pathways by which contaminants could potentially be transported

off-site. Specific exposure scenarios were developed to represent potential situations in which humans may be exposed to on-site contaminants.

Potential migration pathways common to all five sites included the following:

- Migration of surface soil contaminants directly via surface runoff, windblown dust, or tracking (tires, shoes, etc.);
- Migration of surface soil contaminants indirectly via precipitation, leaching and subsequent ground water migration, via volatilization to ambient air, or via uptake by plants or animals and subsequent human consumption;
- Migration of subsurface soil contaminants via precipitation, leaching and subsequent ground water migration; and
- Migration of ground water contaminants via ground water flow.

Ground water is not used as a drinking water source on or downgradient of any of the sites evaluated.

Potential current human exposure scenarios developed for evaluation at the majority of the sites included the following:

- **Trespassing Scenario** - Exposure to children through direct access to the site (e.g., trespassers)

Potential future human exposure scenarios developed for evaluation at a majority of the sites included the following:

- **Construction Scenario** - Exposure to adult construction workers for a one year period assuming development of the site as an industrial/residential site and no remedial activities prior to construction;
- **Commercial/Industrial Use Scenario** - Exposure to adult employees through commercial/industrial use of the site; and
- **Residential Use Scenario** - Exposure to children from 0 to 6 years of age and to adults (30 year period) through future residential use of the site.

Assumptions used in evaluating each exposure scenario were developed to be conservative yet representative of current and anticipated conditions. Uncertainties associated with these assumptions were addressed for each scenario at each site.

Toxicity Assessment - For each site, the toxic effects of each chemical of concern were evaluated, including effects associated with exposure and concentrations at which such effects may be expected to occur, when available. Chronic and subchronic non-carcinogenic effects for the oral and inhalation routes and slope factors associated with these effects were identified.

Risk Characterization - Human health risks were presented with regard to potential effects from the contaminants of concern. These effects may include potential risks of cancer or non-cancerous (systemic) effects. Cancer risk levels, the lifetime incremental probabilities of excess cancer due to exposure to the site, take into account exposure concentrations and the carcinogenic potencies of the chemicals. They are calculated by multiplying exposure dose by the appropriate cancer slope factor for each compound and exposure route. Health effects associated with exposures to non-carcinogenic chemicals were evaluated primarily with regard to reference dose (RfD) values. The associated risk was quantitated by the Hazard Index ratio, which is the ratio of the exposure dose to the RfD.

The results of the quantitative risk analysis are presented in two basic forms. For carcinogenic risks, risk estimates are presented in scientific notation, where a lifetime risk of $1E-04$ represents a lifetime risk of one in ten thousand. The calculated risk is compared to the acceptable total site risk range ($1E-04$ to $1E-06$) for evaluating the need for remediation, as stated in 40 CFR Part 300 (March 8, 1990). Both average case (based on the geometric mean of the on-site data) and maximum (worst case based on the highest concentration detected on-site) cancer risk estimates were calculated. For non-carcinogenic risks, the Hazard Index Ratio is used. When the total Hazard Index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects. Thus, the cancer risk and hazard index ratios that constitute a potential concern are $>1E-04$ and $>1E+00$, respectively.

In the qualitative risk assessment, analytes for which quantitative assessments could not be conducted were evaluated to determine if their omission from the quantitative assessment would be expected to have a significant impact on the overall risk posed by the site.

The uncertainty analysis identified the major sources of uncertainty in the risk assessment as follows:

- Exposure assumptions;
- Exclusion of chemicals due to lack of quantitation or missing toxicity data;

- The use of models to estimate concentrations of chemicals in fugitive dust and the volatilization of chemicals during home use of ground water;
- Data uncertainties due to infrequent detections, limited numbers of samples, qualified data, or uncertainties in background sampling locations;
- Toxicity value extrapolations; and
- Potential interactions between carcinogens and between non-carcinogens which could lead to increased or diminished carcinogenic responses or toxicity.

Individual descriptions of the Human Health Evaluations are presented for each of the five areas of concern in the following sections.

TABLE OF CONTENTS

<u>SECTION</u>		<u>PAGE</u>
EXECUTIVE SUMMARY		ES-1
1.0	BASILINE HEALTH RISK ASSESSMENT	1-1
1.1	Objectives	1-1
1.2	Methodology	1-2
2.0	MCALLISTER POINT LANDFILL - SITE 01	2-1
2.1	Identification of Chemicals of Potential Concern	2-1
2.1.1	Data Collection	2-1
2.1.2	Data Evaluation	2-2
2.1.3	Summary of Surface Soil Data	2-4
2.1.4	Summary of Subsurface Soil (Boring) Data	2-6
2.1.5	Summary of Ground Water Data	2-8
2.1.6	Selection of Chemicals of Concern	2-9
2.2	Contaminant Fate and Transport	2-10
2.2.1	Potential Routes of Migration	2-11
2.2.2	Contaminant Distribution and Observed Migration	2-12
2.3	Exposure Assessment	2-18
2.3.1	Development of Exposure Scenarios	2-18
2.3.2	Exposure Scenarios Addressed in the Health Assessment	2-19
2.3.3	Estimating Environmental Concentrations	2-22
2.3.4	Evaluating Uncertainty	2-23
2.4	Toxicity Assessment	2-28
2.5	Risk Characterization	2-28
2.5.1	Quantitative Risk Assessment	2-28
2.5.2	Qualitative Analysis of Risks	2-45
2.5.3	Uncertainty Assessment	2-49
3.0	MELVILLE NORTH LANDFILL - SITE 02	3-1
3.1	Identification of Chemicals of Potential Concern	3-1
3.1.1	Data Collection	3-1
3.1.2	Data Evaluation	3-2
3.1.3	Summary of Surface Soil Data	3-4
3.1.4	Summary of Subsurface Soil Data	3-6
3.1.5	Summary of Monitor Well Data	3-8
3.1.6	Selection of Chemicals of Concern	3-9
3.2	Contaminant Fate and Transport	3-11
3.2.1	Potential Routes of Migration	3-11
3.2.2	Contaminant Distribution and Observed Migration	3-12
3.3	Exposure Assessment	3-18
3.3.1	Development of Exposure Scenarios	3-18
3.3.2	Exposure Scenarios Addressed in the Health Assessment	3-19
3.3.3	Estimating Environmental Concentrations	3-21
3.3.4	Evaluating Uncertainty	3-22
3.4	Toxicity Assessment	3-27
3.5	Risk Characterization	3-27
3.5.1	Quantitative Risk Assessment	3-27

TABLE OF CONTENTS
(Continued)

<u>SECTION</u>		<u>PAGE</u>
	3.5.2 Qualitative Analysis of Risks	3-37
	3.5.3 Uncertainty Assessment	3-41
4.0	OLD FIRE FIGHTING TRAINING AREA - SITE 09	4-1
4.1	Identification of Chemicals of Potential Concern	4-1
4.1.1	Data Collection	4-1
4.1.2	Data Evaluation	4-2
4.1.3	Summary of Surface Soil Data	4-4
4.1.4	Summary of Subsurface Soil Data	4-6
4.1.5	Summary of Monitor Well Data	4-7
4.1.6	Selection of Contaminants of Concern	4-9
4.2	Contaminant Fate and Transport	4-10
4.2.1	Potential Routes of Migration	4-11
4.2.2	Contaminant Distribution and Observed Migration	4-12
4.3	Exposure Assessment	4-17
4.3.1	Development of Exposure Scenarios	4-17
4.3.2	Exposure Scenarios Addressed in the Health Assessment	4-19
4.3.3	Estimating Environmental Concentrations	4-21
4.3.4	Evaluating Uncertainty	4-22
4.4	Toxicity Assessment	4-27
4.5	Risk Characterization	4-28
4.5.1	Quantitative Risk Assessment	4-28
4.5.2	Qualitative Analysis of Risks	4-38
4.5.3	Uncertainty Assessment	4-43
5.0	TANK FARM FOUR - SITE 12	5-1
5.1	Identification of Chemicals of Potential Concern at Tank Farm 4.	5-1
5.1.1	Data Collection	5-1
5.1.2	Data Evaluation	5-2
5.1.3	Summary of Surface Soil Data	5-5
5.1.4	Summary of Subsurface Soil Data	5-7
5.1.5	Summary of Surface Water Data	5-9
5.1.6	Summary of Ground Water Data	5-10
5.1.7	Selection of Chemicals of Concern	5-11
5.2	Contaminant Fate and Transport	5-12
5.2.1	Potential Routes of Migration	5-13
5.2.2	Contaminant Distribution and Observed Migration	5-14
5.3	Exposure Assessment	5-18
5.3.1	Development of Exposure Scenarios	5-18
5.3.2	Exposure Scenarios Addressed in the Health Assessment	5-20
5.3.3	Estimating Environmental Concentrations	5-25
5.3.4	Evaluating Uncertainty in the Exposure Analysis	5-26
5.4	Toxicity Assessment	5-31

TABLE OF CONTENTS
(Continued)

<u>SECTION</u>		<u>PAGE</u>
5.5	Risk Characterization	5-31
5.5.1	Quantitative Risk Assessment	5-31
5.6	Qualitative Analysis of Risks	5-43
5.7	Uncertainty Assessment	5-46
6.0	TANK FARM FIVE - SITE 13	6-1
6.1	Identification of Chemicals of Potential Concern at Tank Farm 4.	6-1
6.1.1	Data Collection	6-1
6.1.2	Data Evaluation	6-2
6.1.3	Summary of Surface Soil Data for Tank Farm 5	6-4
6.1.4	Summary of Subsurface Soil Data	6-7
6.1.5	Summary of Surface Water Data	6-9
6.1.6	Summary of Ground Water Data	6-9
6.1.7	Selection of Chemicals of Concern	6-11
6.2	Contaminant Fate and Transport	6-12
6.2.1	Potential Routes of Migration	6-13
6.2.2	Contaminant Distribution and Observed Migration	6-14
6.3	Exposure Assessment	6-18
6.3.1	Development of Exposure Scenarios	6-18
6.3.2	Exposure Scenarios Addressed in the Health Assessment	6-19
6.3.3	Estimating Environmental Concentrations	6-24
6.3.4	Evaluating Uncertainty in the Exposure Analysis	6-25
6.3.5	Selection of Chemicals of Concern	6-30
6.4	Toxicity Assessment	6-32
6.5	Risk Characterization	6-32
6.5.1	Quantitative Risk Assessment	6-32
6.6	Qualitative Analysis of Risks	6-44
6.7	Uncertainty Assessment	6-48
7.0	REFERENCES	7-1

APPENDICES

APPENDIX

A	RISK ASSESSMENT METHODS AND RESULTS - MCALLISTER POINT LANDFILL
B	RISK ASSESSMENT METHODS AND RESULTS - MELVILLE NORTH LANDFILL
C	RISK ASSESSMENT METHODS AND RESULTS - OLD FIRE FIGHTING TRAINING CENTER
D	RISK ASSESSMENT METHODS AND RESULTS - TANK FARM FOUR
E	RISK ASSESSMENT METHODS AND RESULTS - TANK FARM FIVE
F	TOXICOLOGICAL PROFILES
G	PHYSICAL/CHEMICAL AND ENVIRONMENTAL FATE PROPERTIES

LIST OF TABLES

TABLE

2-1	SUMMARY OF SURFACE SOIL DATA - MCALLISTER POINT LANDFILL
2-2	SUMMARY OF SUBSURFACE DATA - MCALLISTER POINT LANDFILL
2-3	SUMMARY OF MONITOR WELL DATA - MCALLISTER POINT LANDFILL
2-4	SUMMARY OF DETECTED CONTAMINANTS - MCALLISTER POINT LANDFILL
2-5	SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - MCALLISTER POINT LANDFILL
2-6	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 1
2-7	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 1
2-8	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 2
2-9	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 2
2-10	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 3
2-11	SUMMARY OF SUBCHRONIC HAZARD INDEX ESTIMATES - SCENARIO 3
2-12	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 4
2-13	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 4
2-14	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 5
2-15	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 5
2-16	UPTAKE/BIOKINETIC MODEL - INPUTS AND OUTPUTS USING THE GEOMETRIC MEAN SOIL LEAD FOR THE ENTIRE SITE
2-17	UPTAKE/BIOKINETIC MODEL - INPUTS AND OUTPUTS USING THE GEOMETRIC MEAN SOIL LEAD FOR THE "IMPACTED" ZONE
2-18	UPTAKE/BIOKINETIC MODEL - INPUTS AND OUTPUTS USING THE MAXIMUM SOIL LEAD FOR THE ENTIRE SITE
2-19	LEAD UPTAKE/BIOKINETIC MODEL RESULTS FOR MCALLISTER POINT
2-20	SUMMARY OF EXPOSURE PATHWAYS - MCALLISTER POINT LANDFILL
3-1	SUMMARY OF SURFACE SOIL DATA - MELVILLE NORTH LANDFILL
3-2	SUMMARY OF SUBSURFACE DATA - MELVILLE NORTH LANDFILL
3-3	SUMMARY OF MONITOR WELL DATA - MELVILLE NORTH LANDFILL
3-4	SUMMARY OF DETECTED CONTAMINANTS - MELVILLE NORTH LANDFILL
3-5	SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - MELVILLE NORTH LANDFILL
3-6	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 1
3-7	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 1
3-8	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 2
3-9	SUMMARY OF SUBCHRONIC HAZARD INDEX ESTIMATES - SCENARIO 2
3-10	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 3
3-11	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 3
3-12	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 4
3-13	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 4
3-14	SUMMARY OF EXPOSURE PATHWAYS - MELVILLE NORTH LANDFILL
4-1	SUMMARY OF SURFACE SOIL DATA - OLD FIRE FIGHTING TRAINING AREA
4-2	SUMMARY OF SUBSURFACE DATA - OLD FIRE FIGHTING TRAINING AREA
4-3	SUMMARY OF MONITOR WELL DATA - OLD FIRE FIGHTING TRAINING AREA
4-4	SUMMARY OF DETECTED CONTAMINANTS - OLD FIRE FIGHTING TRAINING AREA
4-5	SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - OLD FIRE FIGHTING TRAINING AREA
4-6	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 1
4-7	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 1
4-8	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 2
4-9	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 2

LIST OF TABLES
(Continued)

TABLE

4-10	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 3
4-11	SUMMARY OF SUBCHRONIC HAZARD INDEX ESTIMATES - SCENARIO 3
4-12	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 4
4-13	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 4
4-14	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 5
4-15	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 5
4-16	SUMMARY OF EXPOSURE PATHWAYS - OLD FIRE FIGHTING TRAINING AREA
5-1	SUMMARY OF SURFACE SOIL DATA - TANK FARM FOUR
5-2	SUMMARY OF SUBSURFACE DATA - TANK FARM FOUR
5-3	SUMMARY OF MONITOR WELL DATA - TANK FARM FOUR
5-4	SUMMARY OF SURFACE WATER DATA - TANK FARM FOUR
5-5	SUMMARY OF SEDIMENT DATA - TANK FARM FOUR
5-6	SUMMARY OF DETECTED CONTAMINANTS - TANK FARM FOUR
5-7	SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - TANK FARM FOUR
5-8	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 1
5-9	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 1
5-10	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 2
5-11	SUMMARY OF SUBCHRONIC HAZARD INDEX ESTIMATES - SCENARIO 2
5-12	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 3
5-13	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 3
5-14	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 4
5-15	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 4
5-16	SUMMARY OF EXPOSURE PATHWAYS - TANK FARM FOUR
6-1	SUMMARY OF SURFACE SOIL DATA - TANK FARM FIVE
6-2	SUMMARY OF SUBSURFACE SOIL DATA - TANK FARM FIVE
6-3	SUMMARY OF MONITOR WELL DATA - TANK FARM FIVE
6-4	SUMMARY OF SURFACE WATER DATA - TANK FARM FIVE
6-5	SUMMARY OF DETECTED CONTAMINANTS - TANK FARM FIVE
6-6	SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - TANK FARM FIVE
6-7	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 1
6-8	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 1
6-9	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 2
6-10	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 2
6-11	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 3
6-12	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 3
6-13	SUMMARY OF CANCER RISK ESTIMATES - SCENARIO 4
6-14	SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES - SCENARIO 4
6-15	SUMMARY OF EXPOSURE PATHWAYS - TANK FARM FIVE

LIST OF FIGURES

FIGURE

2-1	BLOOD LEAD DISTRIBUTION IN 0-6 YEAR OLD CHILDREN AT MCALLISTER POINT (GEOMETRIC MEAN SOIL LEAD FOR THE ENTIRE SITE)
2-2	BLOOD LEAD DISTRIBUTION IN 0-6 YEAR OLD CHILDREN AT MCALLISTER POINT (GEOMETRIC MEAN SOIL LEAD FOR THE "IMPACTED" ZONE)
2-3	BLOOD LEAD DISTRIBUTION IN 0-6 YEAR OLD CHILDREN AT MCALLISTER POINT (MAXIMUM SOIL LEAD FOR THE ENTIRE SITE)

1.0 BASELINE HEALTH RISK ASSESSMENT

1.1 Objectives

This report provides a quantitative health risk assessment (Human Health Evaluation) for five Naval Education and Training Center (NETC) sites (including the McAllister Point Landfill, the Melville North Landfill, the Old Fire Fighting Training Center, Tank Farm Four and Tank Farm Five) in Newport, Rhode Island. Its primary objectives are to examine exposure pathways and contaminant concentrations in environmental media, and to estimate the potential for adverse effects associated with the contaminants of concern at the site under current and future land use conditions. The risk assessment follows guidelines established by the U.S. Environmental Protection Agency (EPA, 1989 and 1989a).

For each site, specific exposure scenarios have been considered and developed to represent potential situations in which humans may be exposed to contaminants originating from the site. Efficacy of specific remedial programs are not included as part of this analysis.

Human health risks associated with each site are presented with regard to potential effects from the contaminants of concern. These effects may include potential risks of cancer or non-cancerous (systemic) effects. A quantitative risk assessment for carcinogens involves calculations of the lifetime incremental probabilities of cancer that take into account exposure concentrations and the carcinogenic potencies of the chemicals. Health effects associated with exposures to noncarcinogenic chemicals are evaluated primarily with regard to reference dose (RfD) values. This approach for non-cancer effects is most useful when exposure doses of the chemical are below the RfD thresholds. However, there is often no quantitative way to

measure the degree of risk created when concentrations exceed the standard thresholds.

Ultimately, the risk assessment presented in this report is expected to be used within a risk management framework. In making decisions concerning what, if anything, should be done at a site (including, for example, the collection of additional data or implementation of a remedial program), the results of the risk assessment should be used in concert with other information on the site. The risk assessment will also identify site or land use conditions that present unacceptable risks. The results of the risk assessment identify contaminants and exposure pathways contributing the greatest risk to the receptor population. From this information, recommendations for future activities at the site can be made such that public health is protected.

This human health evaluation focuses most strongly on the baseline conditions at the site. However, the results of this study will help decision makers focus on the areas, contaminants, media, pathways and receptors of greatest concern at the site, thereby helping to identify future remedial alternatives for the site.

1.2 Methodology

The methodology is structured utilizing the most current methods accepted by the EPA in the Interim Final Risk Assessment Guidance for Superfund, Volume I (Human Health Evaluation Manual - Part A) (1989) and Supplemental Risk Assessment Guidance for the Superfund Program, Part 1 - Guidance for Public Health Risk Assessments (1989a). Where assumptions are made, they are realistic but conservative, i.e., protective of public health. In keeping with accepted practices for conducting such assessments, all assumptions are

carefully discussed and an assessment made of the uncertainty associated with the overall health and environmental risk estimates.

Following the guidelines accepted by the EPA, the basic components of the public health risk assessment will be organized and presented for each site as follows:

- Data Collection;
- Data Evaluation;
- Contaminant Fate and Transport;
- Exposure Assessment;
- Toxicity Assessment; and
- Risk Characterization.

Each of these components are discussed in detail in relation to each site.

2.0 MCALLISTER POINT LANDFILL - SITE 01

The McAllister Point Landfill site is located along Narragansett Bay and is bordered to the east by the Penn Central Railroad line and the Defense Highway. The site was used as a sanitary landfill over a twenty year period, with eventual closure in the mid-1970's. The site is not currently used for any naval activities.

2.1 Identification of Chemicals of Potential Concern

2.1.1 Data Collection

A geophysical survey was conducted prior to initiation of sampling activities. Fifteen surface soil samples were collected from on-site locations, while two off-site surface soil samples were collected as background samples. On-site surface soil samples included four samples collected along the shoreline of Narragansett Bay and eleven samples collected from outside of suspected capped landfill areas, to characterize undisturbed site soil conditions. Cap soils were reportedly chemically characterized in a previous site investigation (conducted by others). The off-site samples were collected to determine background surface soil inorganics levels.

Twelve soil test borings were located throughout the site, with one test boring located off-site to the east. In addition, soil samples were collected from seven well borings completed across the site. Two to three samples were generally collected from each boring located in the fill area: one from the fill material, one from immediately beneath the fill material, and one at the water table. Observed fill materials are generally characterized as consisting of domestic-type wastes. One near-surface soil sample was collected from the off-site test boring.

Ground water samples were collected in April 1990 from seven newly installed wells and 3 pre-existing wells. Two additional wells were subsequently installed and then sampled in July 1990. Oil was present in one well (MW-5S) in September 1990.

A leachate spring sample was also collected in August 1990 from the shoreline of the landfill.

2.1.2 Data Evaluation

As detailed in the RI report, the site contains residues from the on-site disposal of wastes between 1955 and the mid-1970's. Field studies have revealed the presence of numerous organic and inorganic contaminants in the soils and ground water.

In order to organize the data into a form manageable and appropriate for the baseline risk assessment the following steps were followed during the data evaluation process as described by EPA (1989):

- 1) Gather and sort all data by medium (i.e. surface soil, subsurface soil and ground water);
- 2) Evaluate methods of analysis;
- 3) Evaluate the sample quantitation limits;
- 4) Evaluate the data qualifiers and codes;
- 5) Evaluate blank data;
- 6) Evaluate tentatively identified compounds (TIC's);
- 7) Evaluate background data;
- 8) Develop data sets by medium; and
- 9) Develop a set of chemicals of potential concern from the entire data set.

Briefly, the specific methods used for the McAllister Point Landfill site include the following, which correlate with the previously described steps.

- 1) All analytical data was initially sorted by media (surface soil, subsurface soil, and ground water);
- 2) An evaluation of analytical methods was not considered to be necessary as all data used was analyzed by EPA's Superfund Contract Laboratory Program (CLP) procedures;
- 3) Unusually high sample quantitation limits (SQL's) were not commonly reported in any of the matrices analyzed. This indicates that in most cases, matrix or chemical interferences in the analytical determinations did not cause a loss of sensitivity at this site. One-half of the SQL was used for a non-detectable reading if there was evidence that the chemical is present in that medium. However, for non-detects where it appeared more likely that the chemical could be present at a value greater than 1/2 the SQL, the entire SQL was used. The decision to use the full SQL or 1/2 the SQL was based upon extent and degree of contamination within each medium and potential for migration between media. If a chemical was not detected in a single medium, transport and fate information was used to determine if its presence in related media should dictate that it be included in the analysis of this apparently non-impacted medium;
- 4) Data validation qualifiers were assessed during the data evaluation process. As indicated in EPA guidance (EPA, 1989 and 1989a), data qualified with U, J or UJ qualifiers were used in the quantitative risk assessment when appropriate. Chemical data qualified with a "U" (not detected) was used as one half the SQL. Non-detect values were not ignored based on the presence of "hits" within the same media or based on uncertainty associated with analysis (i.e., "UJ" qualified data);
- 5) Field and laboratory blanks were used to segregate actual site contamination from cross contamination from field or laboratory procedures. As indicated in EPA (1989), sample results were considered positive only if concentrations exceeded ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a chemical that is not considered a common laboratory contaminant;
- 6) Tentatively identified compounds (TICs) were reported in surface and subsurface soil samples across the site. TICs ranged from none to three or four unknowns at low concentrations (10-20 µg/kg) to many TICs (>20) each at elevated concentrations (up to 100 mg/kg). Similar results were reported for TICs in ground water. Due to the uncertainty associated with the quantitative and qualitative nature of these TICs, a quantitative assessment of risk associated with exposure was not included in this assessment;

- 7) Background soil sampling locations were identified for this site. Surface soil samples SS-15 and SS-16 and a near-surface soil boring sample (BB-01 from 0-2 feet) were collected from off-site locations and used as reference points. National background levels were used as a screening method to evaluate non-site related chemicals or commonly encountered naturally occurring chemicals in soil. Monitoring well 23 (MW-23) is located upgradient of the landfill and off of the landfill site. This monitoring well was used as an indication of background ground water conditions; and
- 8) Tables 2-1 through 2-3 provide the chemicals and concentrations sampled in surface soils, subsurface soils, and ground water, respectively. Soil samples taken near the shoreline were included in surface soil analyses. The leachate spring sample was not included in this assessment. Surface water sampling (Narragansett Bay) was not included in the Phase I investigation. Table 2-4 provides a summary of chemicals of potential concern in each media.

2.1.3 Summary of Surface Soil Data

Table 2-1 presents a summary of the analytical data associated with chemicals detected in surface soil, organized by class, including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class of chemicals is discussed in detail below.

- Inorganics

All of the inorganics analyzed were detected at a minimum of one of the eighteen locations on-site. Cyanide, mercury and sodium were detected least frequently (2/18, 3/18 and 3/18, respectively). SQL for inorganics were not unusually high. Comparisons to background levels (see Table 2-1) indicated a general trend of elevated concentrations across the site for antimony, arsenic, cadmium, cobalt, copper, lead, mercury, nickel and zinc. Soil lead was particularly elevated at one near-shoreline location (SS-15), where the level was 1,980 ppm.

- Volatile Organics

The most frequently detected VOC is acetone (8/16). Other frequently detected VOCs include 2-hexanone, chlorobenzene, ethylbenzene (all detected 5/16) and styrene, 1,1,2,2-tetrachloroethane, tetrachloroethene, toluene and xylene (each detected 6/16). All other VOCs were detected at a minimum of one sampling location. In general, concentrations of all VOCs were low (near or below SQL). Analytical data for 2-butanone was rejected during the data validation process (Table 2-1). Based on this information, quantitative assessment of risk was not addressed for 2-butanone.

- Semi-Volatile Organics

Of the sixty-five (65) semi-volatile organics analyzed for in surface soil (and listed in Table 2-1), all were detected at a minimum of one of the sixteen sampling locations. Forty-one semi-volatile compounds were detected only one time (see Table 2-1). Polycyclic aromatic hydrocarbons (PAHs) detected frequently include acenaphthene (9/16), anthracene (12/16), benzo(a)anthracene (16/16), benzo(a)pyrene (15/16), benzo(b)fluoranthene (15/16), benzo(k)fluoranthene (15/16), benzo(g,h,i)perylene (14/16), chrysene (16/16), dibenzo(a,h)anthracene (11/16), fluoranthene (16/16), fluorene (9/16), indeno(1,2,3cd)pyrene (14/16), phenanthrene (16/16) and pyrene (15/16). Concentrations of PAHs range from below detection limits (0.044 mg/kg for naphthalene) to 46 mg/kg (fluoranthene).

Phthalate esters detected in surface soils include bis(2-ethylhexyl)-phthalate (3/16), butylbenzylphthalate (3/16), diethylphthalate (2/16), and di-n-octylphthalate (4/16). These compounds were detected at a range of 0.37 mg/kg (di-n-octylphthalate) to 7.9 mg/kg (bis(2-ethylhexyl)phthalate, butylbenzylphthalate and di-n-octylphthalate). Table 2-1 presents the range

of sample quantitation limits (SQL) for surface soil. Unusually high SQL's occurred in surface soil samples.

- Pesticides/PCBs

The most frequently detected Pesticides/PCBs included 4,4'-DDD, 4,4'-DDE, 4,4'-DDT and Aroclor-1254, at frequencies of 3/16, 4/16, 11/16 and 5/16, respectively. Concentrations of DDD, DDE and DDT were generally low, with a range of 0.007 mg/kg (<SQL) for DDT to 1.8 mg/kg (also for DDT). PCB concentrations were also low, ranging from 0.13-0.61 mg/kg in surface soil.

2.1.4 Summary of Subsurface Soil (Boring) Data

Table 2-2 presents a summary of the analytical data associated with chemicals detected in subsurface soil, organized by class including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class is discussed in detail as follows. Depths to twelve feet were used in the risk assessment based on potential site uses.

- Inorganics

Of the inorganics analyzed, only thallium was not detected at any of the twenty-eight (28) sampling locations. Many inorganics were detected at or near a frequency of 100% (see Table 2-2). SQL's for inorganics were not unusually high, and means were not adjusted based on the exclusion of "UJ" data. Comparisons to U.S. background levels (see Table 2-2) indicated a general trend of elevated concentrations across the site for antimony, arsenic, cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium and zinc.

Volatile Organics

Methylene chloride was not detected on-site. All other VOCs were detected at a frequency greater than 5% (Table 2-2). The most frequently detected VOCs include tetrachloroethene (10/28), bromoform (10/28), toluene (15/28), ethylbenzene (13/28), xylene (13/28) and trichloroethene (13/28). In general, concentrations of VOCs in subsurface soil were low (near or below the SQL). No unusually high SQLs were detected for VOCs.

- Semi-Volatile Organics

All of the sixty-five (65) semi-volatile organics listed in Table 2-2 for subsurface soil were detected at a frequency of greater than 5%. Phenol, detected the most infrequently, was found in 12 of 26 possible sampling locations. The most frequently detected compounds include 2-methylnaphthalene (20/26), benzo(a)anthracene (23/26), benzo(a)pyrene (20/26), benzo(b)-fluoranthene (22/27), benzo(k)fluoranthene (21/26), chrysene (23/26), fluoranthene (24/26), naphthalene (20/26), phenanthrene (23/26) and pyrene (24/26). In general, concentrations of semi-volatile organic compounds were low, and rarely exceeded SQL's. Unusually high SQL's did not occur frequently in subsurface soil samples.

- Pesticides/PCBs

All twenty (20) pesticides and seven (7) PCBs analyzed for were detected in subsurface soil at frequencies greater than 5%. The most frequently detected pesticides included 4,4'-DDD (22/26) and 4,4'-DDE (18/26). All other pesticides were detected at 16 of 26 possible locations. Aroclor-1242 was the most frequently detected PCB (19/26). All other PCBs were detected at a minimum of 16 out of 26 possible locations. Concentrations of pesticides/PCBs

were low (at or near the SQL). The maximum detected pesticide concentration in subsurface soil was toxaphene at 2 mg/kg. However, with the exception of DDD, DDE, and DDT, detections of pesticides were all qualified as "U" or "UJ". Similarly, data for Aroclor-1016, Aroclor-1221, Aroclor-1232 and Aroclor-1260 were all qualified as "U" or "UJ".

2.1.5 Summary of Ground Water Data

Table 2-3 presents a summary of the analytical data associated with compounds detected in a single round of ground water monitoring data. Each class of chemicals is discussed in detail below, with the exception of pesticides/PCBs, which were not detected at any sampling location.

- Inorganics

All inorganics were detected at a minimum of one of the ten possible sampling locations. Cyanide, selenium, silver, thallium and vanadium were detected infrequently (2/10 or less). SQL's for inorganics were not unusually high, and mean values were not adjusted based on the exclusion of "UJ" data.

- Volatile Organics

All VOCs were detected at a minimum of one of the ten sampling locations. The most frequently detected VOCs included acetone, a common laboratory contaminant, and 2-hexanone (both detected at a frequency of 8/10). In general, concentrations of VOCs were low and most data points were qualified as "U" or "UJ".

- Semi-Volatile Organics

In a single round of ground water monitoring, the following semi-volatile organic compounds were not detected: 2-chlorophenol, 2-methylphenol,

2-nitrophenol, 2,4-dichlorophenol, 2,4-dinitrophenol, 2,4,5-trichlorophenol, 2,4,6-trichlorophenol, 4-nitrophenol, 4,6-dinitro-2-methylphenol, pentachlorophenol and phenol. The most frequently detected semi-volatile compounds detected in ground water include: 2-methylnaphthalene (4/10), diethylphthalate (5/10) and naphthalene (4/10). All other compounds were detected one or more times. In general, concentrations of semi-volatile organic compounds were low (at or below the SQL) and much of the analytical data was qualified as "U" or "UJ". The semi-volatile organic compound with the highest detected concentration was naphthalene at a concentration of 0.24 mg/l.

2.1.6 Selection of Chemicals of Concern

Table 2-4 presents a summary of chemicals of potential concern in all media sampled (as a range of detection). Chemicals carried through the quantitative risk assessment are marked with a single asterisk (*) to the left of the chemical name. Chemicals discussed in the qualitative risk assessment are marked with two asterisks (**) to the left of the chemical name. Those chemicals addressed both quantitatively and qualitatively are marked with 3 asterisks (***). Chemicals detected on site and associated completely with data qualifiers ("U" or "UJ" designations) are noted accordingly. Finally, contaminants of concern for this site are labeled in Table 2-4.

Chemicals of potential concern were selected from Tables 2-1 through 2-3 based upon their presence in a matrix and their potential to produce toxic effects. All chemicals positively identified in a matrix are included as chemicals of concern, and the associated risks are quantitated if cancer potency factors and RfD values are available. If these are unavailable, then the chemical's potential to produce adverse health impacts is considered for qualitative assessment.

Chemicals of potential concern are also those with "UJ" qualified data because of the uncertainty surrounding the SQL and thus the sensitivity of the analysis. Much of this uncertainty is removed if "UJ" data are the rare exception rather than the rule for a chemical, and there are no other sampling locations where the chemical was detected in that matrix. Further, if the reported SQL is not unusually high and if there are not a priori reasons to suspect that the "UJ" data are in a contaminated zone (e.g., other "hits" in the matrix, site history, visual/odorous indicators), then it is appropriate to treat the data point as not detected and thus exclude it from the quantitative risk assessment.

Some of the chemicals of potential concern listed in Table 2-4 were selected because of "UJ" data. The number of samples collected from each matrix was not always large, and thus there is low confidence that the one or several "UJ" samples represent clear evidence of chemical absence in that matrix. Chemicals of potential concern solely because of "UJ" data were included in the risk assessment only if they are carcinogens. Thus, the uncertainty surrounding the "UJ" data is handled by inclusion of these data in the quantitative risk assessment for carcinogens. In cases where "UJ" data are included in the quantitative assessment, the SQL (not one-half the SQL) was used because of the probability that the SQL was underestimated in these samples.

2.2 Contaminant Fate and Transport

This section of the risk assessment evaluates the fate and transport of contaminants associated with the site and provides an indication of future contaminant movement. Section 2.1 outlines the occurrence of contamination across the site in surface soil, subsurface soil, and ground water. Observed

contamination consists mainly of: numerous inorganics, polycyclic aromatic hydrocarbons (PAHs), few VOCs and DDT (plus breakdown products) in the surface soils; inorganics, PAHs, numerous VOCs and pesticides in the subsurface soils; and numerous inorganics in the ground water.

2.2.1 Potential Routes of Migration

To determine the fate of contaminants of potential concern at the site, information on the physical/chemical and environmental fate properties was collected for site contaminants. This information is presented in Appendix G for selected contaminants of concern. Several of the environmental media studied have the potential for off-site migration, primarily surface soils and ground water. Subsurface soils are not likely to be at risk of transport off-site unless exposed by excavation. Although the subsurface soils contain several chemicals of concern, the mode of transport of the chemicals would be primarily through leaching and ground water transport.

Contaminants in surface soils can migrate or be carried from the site by surface runoff (resulting from precipitation), in the form of fine particulates sorbed to windblown dust, and by users of the site via vehicle tires, shoes, etc. In addition, contaminants can move from the surface soils (leaving the soils in place) through leaching by infiltration of precipitation and transport by ground water, and volatilization to ambient air. Finally, transport of contaminants to plants or animals which may potentially be consumed by humans is a possible route of migration.

The sampling results have demonstrated that ground water has been impacted by the site thus presenting a possible migration path for contaminants which have leached downward through soils. Ground water is not currently used as a

drinking water source in the vicinity of the site, such that migration off the site via production wells is not occurring.

2.2.2 Contaminant Distribution and Observed Migration

The following section examines contaminant presence across the site, (also discussed in Section 2.1), in combination with the migration pathways to provide an understanding of contaminant persistence and migration at the site. The discussions below are presented with respect to individual contaminants or contaminant groups. Contaminants observed in the environmental samples collected from the site include volatile organic compounds, semi-volatile organic compounds, PCBs, pesticides, and inorganics.

Inorganic Analytes

Many metals have an affinity for soils (particularly clay particles and organic matter in soils) which reduces their mobility. Under extremes of pH, some metals can be rendered mobile. The presence of the inorganic analytes, particularly the naturally occurring elements, must be examined in the context of natural background concentrations, as presented in Table 2-1. The analytes which appeared elevated above U.S. background surface soil levels in one or more samples are: antimony, arsenic, cadmium, cobalt, copper, lead, mercury, nickel and zinc. The analytes which appeared elevated above background in subsurface soil samples include antimony, arsenic, cadmium, cobalt, copper, lead, manganese, mercury, nickel, selenium and zinc.

All inorganics with the exception of cyanide (2/10), selenium (1/10), silver (2/10), thallium (2/10) and vanadium (1/10) were widespread in on-site ground water samples, suggesting migration has occurred from soils and waste materials. Comparison of inorganic concentrations in ground water on-site to

upgradient concentrations (monitoring well MW-22) indicates that a general trend of elevated concentrations occurs for all inorganics with the exception of arsenic and cyanide (Table 2-3). In order to examine the potential migration of inorganics off-site, data from monitoring wells MW-5 and MW-21 were compared to on-site ground water contamination trends. These two wells are located along the shoreline and are representative of ground water quality as it exits the site. Beryllium, nickel and zinc appeared to be slightly elevated in MW-5S, suggesting movement of these analytes in the ground water.

Volatile Organic Compounds

In general, volatile organic compounds (VOCs) were detected infrequently, with some exceptions (e.g., toluene at 15/28 in subsurface soil), and at low concentrations in soils on-site. Detected concentrations generally were qualified on the basis of data validation review and associated with validation qualifiers.

The principal mechanism for the natural removal of aromatic VOCs is through volatilization (EPA, 1979). Vapor pressures (@ approximately 20°C) of the VOCs of concern range from 3.8 mm Hg (2-hexanone) to 1011 mm Hg (chloromethane) and Henry's Law Constants range from 1.49×10^{-5} atm-m³/mol (4-methyl-2-pentanone) to 1.11×10^{-2} atm-m³/mol (chloromethane) (see Appendix G for Physical/Chemical and Environmental Fate Properties). The role of biodegradation in the natural attenuation of these compounds is compound specific. Ranges of half lives of VOCs in surface water tend to be short (1-2 weeks) with a few exceptions. Similarly the role of adsorption is compound specific (e.g. acetone has little tendency to be retained by soils); the amount adsorbed is highly related to the amount of organic carbon in the soil and is represented numerically by the organic carbon/water partition

coefficient (K_{OC}). The compounds with higher K_{OC} (e.g., ethylbenzene) would be preferably partitioned to organic matter in soils and thus would be less likely to be leached from the soils and transported to the ground water. Some aromatic hydrocarbons are highly mobile. Benzene, for example, has a moderate solubility (1750 mg/l), low K_{OC} (83 ml/g) and short half life (1-6 days in surface water). Therefore, benzene, because of its tendency to volatilize and biodegrade, would be mobile but would not be expected to be very persistent in the environment. Conversely, xylenes, with their lower solubilities (198 mg/l) and higher K_{OC} (240 ml/g), would not be as mobile as benzene, but would be more persistent in the environment as they would tend to sorb to soil particles. Examples of VOCs identified in the surface soil samples included tetrachloroethene and toluene, probably as a result of their relatively high K_{OC} , low water solubility and low vapor pressure.

Subsurface soils contained many VOCs; primarily at low concentrations. Subsurface soils showed the greatest pattern of occurrence of VOCs of the three media sampled. VOCs detected most frequently and at the greatest concentration in subsurface soils include ethylbenzene, tetrachloroethene, toluene, trichloroethene and xylenes. In general, these contaminants are only moderately mobile in soils, and their presence in subsurface soils may be enhanced by past disposal practices.

Based on the mobility, vapor pressure, water solubility and potentially, disposal practices, of these VOCs, it is not unusual that increasing patterns of detection were found in subsurface soils as compared to surface soil.

Aromatic and chlorinated hydrocarbons were present in a minimum of one of ten ground water samples. VOCs noted above trace concentrations (>10 $\mu\text{g/l}$ detection limit) in ground water samples included chlorobenzene (11 $\mu\text{g/l}$), ethylbenzene (12 $\mu\text{g/l}$) and xylene (160 $\mu\text{g/l}$). The chemical/physical and

environmental fate data indicate that these hydrocarbons are likely to migrate downward in soils to ground water.

Ground water beneath the site exits the site primarily to the southwest (towards Narragansett Bay) both as shallow and deep ground water. Contamination present in downgradient monitoring wells MW-21 and MW-5 is considered to be indicative of potential migration of contaminants in ground water off-site. In this case, off-site movement is likely to consist of migration into Narragansett Bay. Examination of patterns of VOC occurrence in these wells (both shallow and deep) indicates that some migration of VOCs may be occurring. For example, detectable concentrations of xylenes were noted in monitoring wells MW-5S, MW-5D and MW-21, suggesting VOC migration in ground water.

Semi-Volatile Organic Compounds

The semi-volatile organic compounds were identified in all the media sampled on site. The semi-volatile organic compounds, particularly the PAHs, are persistent in the environment due to their complex chemical nature. Some of the lighter PAHs (fewer aromatic rings) would be subject to biodegradation or volatilization, but the chemical persistence generally increases with increasing number of aromatic rings. Semi-volatile organic compounds are generally characterized by high boiling point, low vapor pressure, and low solubility (except phenols) (Appendix G).

The semi-volatile organic compounds will be divided into the following groups for discussion: polynuclear aromatic hydrocarbons (PAHs) and naphthalene, phenols, and phthalates.

Polynuclear aromatic hydrocarbons (PAHs) were frequently detected in surface and subsurface soils on site. PAHs generally have a very low

solubility (<4.0 mg/l), whereas the solubility of naphthalene is greater (30 mg/l). The K_{OC} 's of PAHs are generally greater than 2,500 ml/g, with many greater than 100,000 ml/g. This indicates that PAHs readily adsorb to organic carbon in soils. This accounts for their infrequent detection in ground water samples. The highest concentrations of PAHs and naphthalene were detected in monitoring well MW-3S, located in the mounded area central to the site. PAHs and naphthalene were not detected in ground water samples from monitoring wells MW-1, MW-3D, MW-5D, MW-7, MW-21 or MW-22. Monitoring wells MW-5 and MW-21 provide an indication of potential off-site contaminant migration. Thus, migration of PAHs and naphthalene from soil to ground water does not appear to be a primary route of concern.

Phenols and phenol compounds are generally more soluble in water than other semi-volatile organic compounds and display a relatively low volatility (the vapor pressure of phenol is less than the aromatic hydrocarbons but slightly greater than naphthalene; the Henry's Law Constant for phenol is much less than that of naphthalene). Based on the relatively low K_{OC} and high solubility of phenols, they would not tend to adsorb to soils' organic matter; but would tend to leach from soil into ground water. Phenol and phenol compounds were not detected in surface soil, while phenol and phenol compounds were detected at a frequency of at least 50% in subsurface soil. The absence of phenol compounds from surface soil may be due to their solubility (leaching potential), which is supported by detection in subsurface soil.

Phenols detected in ground water include 2,4-dimethylphenol, 4-chloro-3-methylphenol and 4-methylphenol. All were detected at trace concentrations, with 2,4-dimethylphenol detected at the greatest frequency (3/10). It is unclear if phenols are migrating off-site at this time, as none of the contaminants detected in ground water on-site were found in monitoring well

MW-21. Both 2,4-dimethylphenol and 4-chloro-3-methylphenol were detected in MW-5S but not MW-5D.

Phthalate compounds were reported in samples from all environmental media collected at the site. It should be noted that phthalates are considered to be common laboratory contaminants and are widespread in the environment (ATSDR, 1987; ATSDR, 1989). Phthalate esters generally occur in association with other semi-volatile organic compounds. They generally exhibit low solubility and high K_{OC} , and so would not be particularly amenable to water transport. This is somewhat consistent with the site data which show the phthalates occur at much greater concentrations in soil samples as compared to ground water. Phthalates detected in ground water include bis(2-ethylhexyl)-phthalate, butylbenzylphthalate, dimethylphthalate, di-n-butylphthalate, di-n-octylphthalate and diethylphthalate, all detected at trace concentrations. Only diethylphthalate was detected in monitoring wells used to indicate migration of contaminants from the site. Specifically, diethylphthalate was detected at concentrations below the detection limit in MW-5S and MW-21.

Pesticides and PCBs

All pesticides and PCBs were detected at least one time in surface soil, while all compounds analyzed for were detected at least sixteen times in subsurface soil. In general, pesticides and PCBs have an affinity for organics in soils (e.g., K_{OC} of DDT is 243,000 ml/g), which tends to render them immobile. In addition, many pesticides and PCBs are very persistent.

Pesticides and PCBs at the site appear confined to soils, as none of these compounds were detected in ground water, and thus do not appear to be migrating from the site.

PCBs are generally regarded to be a significant environmental problem because of their persistence and adverse health effects. However, because of the strong tendency of PCBs to adsorb to organic matter in soils, PCBs do not tend to migrate unless solvents or oils are present (Callahan et al, 1979).

2.3 Exposure Assessment

2.3.1 Development of Exposure Scenarios

The most critical aspect of a technically sound exposure assessment is the identification of exposure routes, together with the identification of human receptors. The McAllister Point Landfill is not currently in use. Landfilling activities ceased in the mid-1970's and no further naval activities have occurred on Site 01. Access to the McAllister Point Landfill is restricted at the road by a gate and a short section of fence. Based on discussions with field personnel, NETC personnel, EPA Region I personnel, and a site visit, the following potential current human exposure scenarios were identified:

- Persons having access to the site (i.e., nearby residents) may be potential receptors (especially children playing on the site). Information from field personnel indicates that children trespass on the site on a frequent basis.
- Ingestion of shellfish from Narragansett Bay. Contaminants may migrate in ground water from the site and be transported to Narragansett Bay, resulting in potential exposures through shellfish contamination.

Several potential future exposure pathways exist at the site, including:

- Use of the site for ballfields. NETC personnel indicate that tentative plans for future use of the site include construction of ballfields for public recreational use.
- Construction of buildings on the site (i.e., development of the site as house lots), presenting a potential for exposure of construction workers to site contaminants.

- Commercial/industrial use of the site, presenting potential exposure of employees to site contamination.
- Residential use of the site, presenting a potential for exposure of adults and children to site contaminants including use of ground water as a potable drinking water source. EPA Region I requires analysis of future residential use of the McAllister Point Landfill site.

Each scenario includes a particular potential "receptor population", and a consideration of the pathways by which those receptors may encounter contaminants of concern. The values and assumptions used for each exposure scenario were prepared in keeping with generally accepted values in the discipline of risk assessment; the values are not based on detailed time-activity studies. Specific assumptions and details for each exposure scenario are presented in Appendix A.

2.3.2 Exposure Scenarios Addressed in the Health Assessment

Scenario 1 - Trespassing Scenario (Current)

Appendix A presents the model inputs for the exposure routes associated with children trespassing on-site as it currently exists. It is assumed that children living within the immediate vicinity of the site may trespass 21 days per year, which is one day per week during the summer and more infrequently during the school year. Additionally, on days in which children trespass/play on-site, it is assumed that all soil ingestion (100 mg) for that day occurs on-site. Children are not likely to enter the site on a regular basis and without adult supervision before the age of 9 years due to the distance of the site from residences. Regular exposures of this nature are not expected beyond the age of 18 years because of changes in the use of recreational time. Play activities are expected to involve contact with surface soil. For dermal exposures, penetration of contaminants in soil was modeled as described

in Appendix A (EPA, 1989a). Absorption of soil contaminants after ingestion is also provided in Appendix A (EPA, 1989a).

Scenario 2 - Recreational Use Scenario (Future)

Tentative plans for future use of the site include installation of ballfields for public recreational use. As a result, children from ages 6-18 years old are expected to receive dermal and ingestion exposures to contaminants in soil. It has been assumed that children will visit the site 104 days/year: five days per week in the summer (10 weeks) and more infrequently during the remainder of the year (3 days per week in the spring and fall = 18 weeks). Play activities are expected to involve contact with surface soil. For dermal exposures, penetration of contaminants in soil was modeled as described in Appendix A (EPA, 1989a). Absorption of soil contaminants after ingestion is also provided in Appendix A (EPA, 1989a).

Scenario 3 - Construction Scenario

Appendix A presents the model inputs for the exposure routes that construction workers involved in site development could potentially encounter. Excavation and site preparation activities could cause workers to receive inhalation exposure to contaminants in dust, as well as dermal and ingestion exposures to contaminants in soil. It is assumed that workers are engaged in construction, with excavation and site preparation activities lasting for a 12-month period. It is also assumed that remediation of contaminants would not occur prior to construction or prior to the occupation of industrial/residential sites (see discussion for Scenario 4 and 5). The inhalation rate is based upon workers undergoing moderate exertion (EPA, 1991), and dermal penetration of contaminants in soil was modeled as described

in Appendix A (EPA, 1989a). The soil ingestion rate used is 480 mg/day (EPA, 1991).

Scenario 4 - Commercial/Industrial Use Scenario

Future use of the site for commercial/industrial purposes presents a potential exposure of employees to site contamination. Such exposures are most likely to include incidental ingestion and dermal exposure to contaminants in soil, and ingestion of contaminants in drinking water. Workers are assumed to spend 250 days/year on site for 25 years. Appendix A presents detailed exposure models and assumptions for the future commercial/industrial use scenario.

Scenario 5 - Residential Scenario: Children and Adults

A scenario relating to current residential exposures resulting from migration of contaminants in ground water to private wells was not constructed because no such wells currently are used. However, based on guidance from EPA Region I, a future use residential scenario was constructed to evaluate the possible risks associated with residing on the site and using the ground water under current conditions of contamination.

Appendix A presents the model inputs for the exposure routes that children and adults who live on site might receive. Children, aged 0-6 years, and adults are modeled to receive exposures through soil/house dust ingestion, dermal contact with soil based upon exposed arms, hands and legs, dermal contact with contaminants in water during showering, inhalation of contaminants in dust outdoors from wind erosion, inhalation of volatile organic compounds released into bathroom air during showering, and ingestion of contaminants in drinking water. These exposures are assumed to occur on

350 days/year for 6 years for children and 30 years for adults, with the exception of ingestion of soil and house dust which is assumed to occur for a 30 year period for adults (EPA, 1989). The time period for outdoor exposure to fugitive dusts is 4 hours/day, and for showering, is 12 minutes/day. Children are assumed to ingest 750 ml water and 200 mg of soil/house dust per day, while for adults, these values are 2 liters of water and 100 mg soil/day.

2.3.3 Estimating Environmental Concentrations

All exposure point concentrations used in assessing receptor dose were calculated as specified in Supplemental Risk Assessment Guidance for the Superfund Program (EPA, 1989a).

The contaminant concentration used in the evaluation of on-site health risk was calculated using the geometric mean method as specified by EPA Region I (EPA, 1989a). Because the majority of the data collected showed a log normal distribution, a geometric mean was calculated rather than an arithmetic mean for all media in this risk assessment. The geometric mean value is typically somewhat lower than the arithmetic mean. However, the exposures are calculated based upon the maximum concentration of an agent detected on-site, as well as for the geometric mean concentration. Therefore, the assessment encompasses the mean level of exposure and risk (average case) and also the upper bound (worst case). Calculation of a geometric mean is less conservative than an arithmetic mean, such that the use of a geometric mean and maximum provides lower and upper bounds on exposure point concentrations.

As indicated in the data evaluation section, non-detect values were included in the calculation of exposure point concentrations (i.e., soil concentrations) either as one-half the SQL or as the SQL itself. These non-detected values include detection limits indicated by a "U" qualifier.

Detection limits indicated by a "UJ" qualifier were generally used as the SQL. SQL's were evaluated in light of detection limits and quantifiable ("hits") concentrations of each contaminant in each media. Each SQL was dependently analyzed and they were incorporated into the quantitative analysis only in those cases in which the compound was detected in the matrix under consideration or in related matrices.

2.3.4 Evaluating Uncertainty

Tables 2-1 through 2-3 summarize contaminant concentrations in soil and ground water, both as a range of detection across the site and as the value used (the mean and the maximum detected concentration) in the risk assessment. Table 2-4 provides a summary of ranges of detected contaminants across all media.

Table 2-5 summarizes the assumptions used to estimate exposure (i.e., soil ingestion rate, exposure frequency, etc.). The exposure estimates produced for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion will focus on these parameters, and the associated range of uncertainty. Table 2-5 is separated into those parameters which apply to all scenarios (i.e., global variables), and those which apply specifically to an individual scenario.

- Global Variables (All Scenarios)

Table 2-5 lists the parameters and associated values which are used in each of the scenarios. Body weight ranges for children (age 9-18 years, 6-18 years and 0-6 years) were derived from EPA (1990). The actual values used represent an average body weight for each of the groups. Similarly, for adults (18-65 years), a range of body weights is presented, along with the

average body weight (70 kg) for the group. While there is a range of body weights for each age group, these ranges are not large, and are not expected to contribute a significant degree of uncertainty to this assessment.

For Scenario 1, the exposure duration (ED) for children was assumed to be nine years, based upon the age range of children (9 to 18) likely to trespass onto the site. In theory, this duration might range from 1 to 18 years, however, it is unlikely that children younger than 9 years of age would visit the site in its current state. For Scenario 2, children ages 6-18 were expected to spend a span of twelve years (childhood) utilizing the public ballfields. The exposure duration value used is the high end of the proposed range (6-18 years). For Scenario 3 (construction), adults were assumed to have an ED of 1 year, which is the time period expected for construction on the site. For Scenario 4, commercial/industrial employees were expected to spend 25 years on site, which is representative of the amount of time expected for employment at one location. Finally, the exposure durations used for Scenario 5 were separated into categories for children and adults. Children were analyzed separately for the first six years of life at the site, while adults were assumed to have an ED equal to 30 years, which is the national upper-bound (90th percentile) time at one residence.

The ranges associated with ED are only large when considering adults. However, the values used are expected to provide conservative estimates and overstate the potential risk.

Averaging time (AT) which is a pathway specific period of exposure for non-carcinogenic effects, calculated as a product of exposure duration and the number of days/year, is dependent on exposure duration, which was discussed above. AT is not expected to lend a large degree of uncertainty to the exposure estimates.

The ranges of relative absorption factors (RAF) for organic and inorganic compounds may vary from no absorption (0) to complete absorption (1). This range is likely to contribute a large degree of uncertainty to the exposure estimates. The values chosen for RAF are representative for classes of compounds, and are provided by EPA Region I (EPA, 1989a).

The permeability constant (PC) for each chemical was assumed to be equal to the penetration rate of water, rather than estimated on a compound-specific basis. Thus, PC may lend a degree of uncertainty in that some compounds will not readily penetrate skin, while others will penetrate at a rapid rate.

The soil contact rate (SCR) established by EPA Region I (EPA, 1989a) is based upon three parameters: soil deposition rate, skin surface area and percent (fraction) exposed. Each of these parameters contains some degree of uncertainty. Soil deposition rate (also known as soil adherence factor) may range up to 2.77 mg/cm² for Kaolin clay (EPA, 1989). The value used by EPA Region I of 0.5 mg/cm² was chosen as a reasonable estimate following a literature review (EPA, 1989a). Thus, a five fold difference exists between the actual value used and an upper bound estimate of adherence. Region I guidance suggests the use of a skin surface area (SA) of 2,000 cm², and is based on the SA of the hands, forearms, feet and lower legs of a young child or the hands and feet of an adult (EPA, 1989a). A large degree of uncertainty is associated with this value, and is dependent on age and area exposed. For example, the 50th percentile total body SA for adult males is 19,400 cm², while the 50th percentile SA for adult male hands is 820 cm² (EPA, 1989). Finally, a factor of 50% is applied to account for the percentage of SA actually covered with soil (EPA, 1989a). This factor is not likely to contribute much uncertainty to the assessment.

The fraction of soil ingested (FI) from the site ranges from 0-1. As a highly conservative estimate, and based on an event-based approach, it was assumed that all soil ingested came from the site.

Concentrations of contaminants in all media were presented as a mean and as a maximum detected concentration. For some chemicals the range of potential concentrations across the site is very large, introducing a high degree of uncertainty to the exposure estimates. However, the exposure estimates are expected to over-predict rather than under-predict, and therefore are likely to be protective of human health.

- Scenario 1 - Trespassing Exposure: Current Use

The exposure frequency (EF; days/year) may range from 1 to 365, which may introduce the greatest degree of uncertainty. The value used (21 days for children) was based on available free time (away from home, school, etc.). The soil ingestion rate may also vary over a large range of values, but the values used are not expected to introduce a large degree of uncertainty into the exposure estimates.

- Scenario 2 - Recreational Exposure: Future Use

As for Scenario 1, the EF provides a relatively large degree of uncertainty. The range of EF values is 1-365 days/year. The value chosen is 104 days/year based on available recreational time.

- Scenario 3 - Construction Exposure: Future Use

Of the parameters presented in Table 2-5, the modeled ambient dust concentration is expected to present the largest degree of uncertainty to the exposure estimates. Exposure point concentrations available at the site

include concentrations in soils and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix A. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results.

- Scenario 4 - Commercial/Industrial Exposure: Future Use

The EF for Scenario 4 is not expected to contribute a large degree of uncertainty to the exposure assessment. Of the possible range of values (1-365 days/year), the value chosen (250 days/year) is most likely to be representative of exposure.

- Scenario 5 - Residential Scenario: Future Use

Of the parameters presented in Table 2-5, the modeling of ambient dust concentrations and indoor airborne vapor phase chemical concentrations are expected to present the largest degree of uncertainty. Exposure point concentrations available at the site include concentrations in soils and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix A. As a

caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results.

2.4 Toxicity Assessment

Appendix F of this report presents a short description of the toxic effects of each chemical of concern, including a summary of the dose-response information pertinent to quantitative risk assessment, as available. Furthermore, Tables F-1 through F-4 present a summary of toxicity values associated with chronic and subchronic noncarcinogenic effects, for the oral and inhalation routes, respectively. Tables F-5 and F-6 summarize the slope factors associated with potential carcinogenic effects of chemicals of concern by the oral and inhalation routes, respectively.

2.5 Risk Characterization

2.5.1 Quantitative Risk Assessment

For potential carcinogens, risks are estimated as probabilities. The compound-specific potency factors for carcinogens are generally estimated through the use of mathematical extrapolation models (e.g., the linearized multistage model). These models estimate the largest possible linear slope, within a 95% confidence interval, at low extrapolated doses. Thus, the potency factor is characterized as a 95% upperbound estimate, such that the true risk is not likely to exceed the upperbound estimate and may be lower.

The evaluation of risk from noncarcinogenic health hazards is based on the use of RfDs (EPA, 1990; EPA, 1989a). RfDs are estimates of daily exposure to

the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period. The RfD is calculated by dividing the no adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty factor, which is multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgement regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a LOAEL to a NOAEL, and
- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used.

The results of the quantitative risk analysis are presented in two basic forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given exposure. In numerical terms, these risk estimates are presented in scientific notation in this report. Thus, a lifetime risk of $1\text{E-}04$ means a lifetime incremental risk of one in ten thousand; a lifetime risk of $1\text{E-}06$ means an incremental lifetime risk of one in one million and so on.

In the cases of exposure to non-carcinogens, the Hazard Index Ratio is used. As noted in previous sections, the fundamental principles used to construct the RfD utilized in calculating the Hazard Index Ratio are predicated on long term or chronic (usually measured in years) exposures and health effects. However, the RfD used was either the RfD derived from chronic studies (RfD_C) or the RfD which was derived from subchronic studies (RfD_S). Wherever possible, the RfD was matched to the type of exposure (chronic vs subchronic) such that in scenarios involving subchronic exposures (e.g., construction), the RfD_S values were used, and those scenarios involving chronic exposure (trespasser, commercial/industrial use, residential use), the RfD_C values were used.

Cancer and non-cancer health risks are discussed below for trespasser (Scenario 1 - current use), recreational (Scenario 2 - future use), construction (Scenario 3 - future use), commercial/industrial (Scenario 4 - future use) and residential (Scenario 5 - future use) scenarios. Within the trespasser, recreational and residential scenarios, the risks to children (9-18 years old, trespasser scenario; 6-18 years old, recreational scenario; 0-6 years old, residential scenario) and adults are presented separately. In each case, daily doses of the compounds of concern have been calculated for each exposure pathway modeled, and these doses were then used to calculate cancer risk levels and hazard index ratios. Cancer risk levels are the lifetime probability of excess cancer due to the exposure pathways resulting from use of the site. Cancer risk levels are derived by multiplying exposure dose by the appropriate cancer slope factor for each compound and exposure route. Non-cancer health risk is quantitated by the hazard index ratio which is the ratio of the exposure dose to the RfD (both in mg/kg/day). The calculated level of cancer risk can be compared to the acceptable total site

— risk range (1E-04 to 1E-06) for evaluating the need for remediation, as stated in the "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (EPA, 40 CFR Part 300, March 8, 1990), and in the Superfund Human Health Evaluation Manual (1E-04 to 1E-07) (EPA, 1989). Regarding non-carcinogenic health hazards the Superfund Human Health Evaluation Manual (EPA, 1989) states that:

"When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that constitute a concern are $>1E-04$ and $>1E+00$, respectively. Tables 2-6 through 2-15 summarize cancer risk levels and hazard index ratios for all scenarios. Appendix A (Tables A.1.1 through A.5.16) contains cancer risk levels and hazard index ratios for all contaminants, pathways and scenarios.

Cancer risks and hazard index ratios are presented in subsequent sections for each scenario and pathway analyzed. These risk levels are presented as a range in which both the average case value (geometric mean chemical concentrations) and the worst case value (maximum concentration found on-site) are provided. In certain cases, the geometric mean value may actually be greater than the maximum risk value because "U" data were included in the geometric mean at one-half the SQL, but "U" data were not included in the formulation of maximum values. This is because it is inappropriate for the maximum risk found on-site to be driven by non-detected values. The maximum values do include "UJ" qualified data at the full SQL. Thus, in those cases where a high SQL for a non-detect is greater than any of the detected levels, it is possible for the geometric mean risk to exceed the maximum risk.

Scenario 1: Trespassing Scenario (Current): Cancer Risks and Hazard Index Ratios

Tables 2-6 and 2-7 summarize the cancer risks and hazard index ratios for all exposure pathways considered. Tables A.1-1 through A.1-6 contain the spreadsheets used to calculate dose, cancer risk and hazard index ratios for Scenario 1.

Exposure of children to contaminants while trespassing on-site is associated with a total cancer risk range of $1.2\text{E-}06$ (average) to $1.8\text{E-}05$ (maximum), both of which are within the acceptable risk range of $1\text{E-}04$ to $1\text{E-}06$. The predominant factor contributing to this risk range is ingestion of carcinogenic PAH compounds in soil.

Trespassing on site is associated with a total hazard index ratio range of $4\text{E-}03$ (average) to $6\text{E-}02$ (maximum) which is below the target HI value of $1.0\text{E+}00$. Incidental ingestion of inorganics in soil is the primary contributor to this risk.

Scenario 2: Recreational Use Scenario (future): Cancer Risks and Hazard Index Ratios

Tables 2-8 and 2-9 summarize the cancer risks and hazard index ratios, respectively, for all exposure pathways. Tables A.2-1 through A.2-6 contain the spreadsheets used to calculate dose, cancer risk and hazard index ratios for Scenario 2.

Exposure of children to contaminants on site during a future recreational use of the site (as ballfields) is associated with a total cancer risk range of $8.7\text{E-}06$ (average) to $1.3\text{E-}04$ (maximum). The maximum risk value slightly exceeds the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. This risk is attributed to the incidental ingestion of carcinogenic PAHs in surface soil.

Future recreational use of the site is associated with a total hazard index ratio range of $2.5\text{E}-02$ (average) to $3.6\text{E}-01$ (maximum) which is below the target value of $1.0\text{E}+00$. Ingestion of inorganics in soil is the primary contributor to this risk.

Scenario 3: Construction Use Scenario (future): Cancer Risks and Hazard Index Ratios

Tables 2-10 and 2-11 summarize the cancer risks and hazard index ratios, respectively, associated with chemicals and exposure pathways included in this scenario. Tables A.3-1 through A.3-9 contain the spreadsheets used to calculate dose, cancer risk and hazard index ratios for Scenario 3.

The total cancer risk range is $3.7\text{E}-06$ (average) to $2.3\text{E}-05$ (maximum), which is within the acceptable risk range ($1\text{E}-06$ to $1\text{E}-04$). Incidental ingestion of PAH compounds in soil is the primary component of this risk. Inhalation of dust-borne contaminants and dermal exposure to contaminants in soil does not appreciably contribute to the cancer risk.

The total hazard index ratio range associated with construction activities is $1.3\text{E}-01$ (average) to $2.5\text{E}+00$ (maximum). The total HI associated with maximum exposure point concentrations is $2.5\text{E}+00$, which exceeds the level of concern for non-carcinogenic effects. Incidental ingestion of soil containing elevated levels of antimony makes the primary contribution to the exceedance of the target HI.

Scenario 4: Commercial/Industrial (future): Cancer Risks and Hazard Index Ratios

Tables 2-12 and 2-13 summarize the cancer risks and hazard index ratios, respectively, for all exposure pathways. Tables A.4-1 through A.4-9 contain

the spreadsheets used to calculate dose, cancer risk and hazard index ratios for Scenario 4.

Future use of the site as an commercial/industrial facility may be associated with a potential risk. Total cancer risk estimates for this scenario range from $1.8\text{E}-03$ (average) to $3.9\text{E}-03$ (maximum). This risk range exceeds the target range of $1\text{E}-06$ to $1\text{E}-04$. The pathway of primary concern associated with this excess risk is ingestion of ground water used as a future potable drinking water supply. Specifically, ingestion of water containing arsenic, beryllium and carcinogenic PAHs is the major contributor of risk. However, it must be noted that the carcinogenic PAHs were not clearly detected on-site because they were associated only with qualified data ("UJ" qualifiers). Ingestion of carcinogenic PAHs in soil provided a minor component of excess cancer risk ($1.3\text{E}-05$ to $2.1\text{E}-04$).

Future commercial/industrial use of the site is associated with a total hazard index ratio range of $1.8\text{E}+00$ (average value) to $1.3\text{E}+01$ (maximum value), both of which exceed the target HI of $1.0\text{E}+00$. As for cancer risk, exceedance of the non-cancer target is associated with the ingestion of contaminants in ground water. Specifically, ingestion of antimony, arsenic and manganese in ground water are the primary contributors to this excess risk.

Scenario 5: Residential Use Scenario (future): Cancer Risks and Hazard Index Ratios

- Children

Tables 2-14 and 2-15 summarize the cancer risks and hazard index ratios, respectively, for all exposure pathways associated with future residential use of the site. Tables A.5-1 through A.5-16 contain the spreadsheets used to calculate dose, cancer risk and hazard index ratios for Scenario 5. The total cancer risk for children age 0-6 years residing on site ranges from $2.3\text{E}-03$

(average value) to $5.8\text{E-}03$, which is above the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$). The pathway of most importance is ingestion of contaminants in drinking water. Specifically, this risk is associated with arsenic (risk range of $2.1\text{E-}04$ to $6.7\text{E-}04$), beryllium (risk range of $4.1\text{E-}05$ to $2.3\text{E-}04$), vinyl chloride ($4.3\text{E-}05$ to $8.1\text{E-}05$), and total carcinogenic PAHs (risk range of $1.8\text{E-}03$ to $3.4\text{E-}03$). As discussed for Scenario 4 (future commercial/ industrial use), average concentrations of the carcinogenic PAHs and vinyl chloride were estimated using qualified data. That is, the data for PAHs is associated with uncertainties which are indicated by "U" (non-detect) or "UJ" (non-detect, but estimated SQL) designation. However, it should be noted that each carcinogenic PAH was detected once in the absence of any data qualifiers (Table 2-4). Furthermore, based on the proximity of Narragansett Bay, the ground water could be brackish and unsuitable for use as a potable water supply. Ingestion of soil also made a substantial contribution to cancer risk ($8.5\text{E-}05$ to $1.3\text{E-}03$) with PAHs in soil contributing 80-90% of this risk. The highest level of cancer risk amongst the remaining pathways was $1.6\text{E-}05$ (worst case) due to VOC inhalation during bathing.

Table 2-15 presents the range of hazard index ratios by exposure pathway. The total HI for children ranges from $9.1\text{E+}00$ to $6.5\text{E+}01$, which is considerably above that which may constitute a concern ($>1\text{E+}00$). The most important component of the HI is ingestion of metals in drinking water including antimony (HI range of $4.6\text{E+}00$ to $3.2\text{E+}01$), arsenic (HI range of $1.4\text{E+}00$ to $4.4\text{E+}00$), cadmium (HI range of $2.5\text{E-}01$ to $2.8\text{E+}00$), chromium (HI range of $3.0\text{E-}01$ to $2.5\text{E+}00$), copper (HI range of $1.8\text{E-}01$ to $3.9\text{E+}00$), manganese (HI range of $1.6\text{E+}00$ to $1.0\text{E+}01$) and zinc (HI range of $1.4\text{E-}01$ to $3.00\text{E+}00$). This pathway accounts for nearly 100% of the total HI in the average case with these inorganics accounting for more than 85% of the total

HI. In the worst case, ingestion of metals in soil (primarily zinc, copper, and antimony) caused an elevated HI ($7.3E+00$).

Risk Assessment for Childhood Lead Exposure

The potential risks from lead is dealt with separately because no RfD or CPF values have been derived for lead, but an alternative approach for evaluating lead-related risks has recently been developed by the U.S. EPA (Marcus, 1988).

This approach, called the Integrated Lead Uptake/Biokinetic Model (U/B Model) incorporates a variety of lead exposure pathways into a series of biologically-based equations that transform exposure dosages into blood lead levels for young children. The key risk parameters are the population geometric mean blood lead level and the upper 95% bound on this mean, with the criteria for adverse effects focused upon exceedances of children's blood lead above 10 $\mu\text{g}/\text{dl}$.

Lead in surface soil is of potential concern at the McAllister Point Landfill site because one sample location had a lead level greater than the threshold for concern, which is 500 ppm (EPA, Region I, personal communication). In addition to the one elevated location (1,980 ppm), several other locations in its immediate vicinity have surface soil lead levels that are elevated with respect to the rest of the site and near the 500 ppm threshold for concern (384-474 ppm). This zone occurs along the Narragansett Bay shoreline (SS-12 to SS-15) and is considered to be a potentially lead-impacted zone. Soil lead results above 500 ppm are of concern due to the potential for children to ingest substantial quantities of soil (200 mg/day for 1-6 year old children) (EPA, 1991). Children are the receptor of primary

concern because of their high exposure relative to body weight, and because low-dose neurotoxic effects are most possible in the very young.

Model Design and Key Parameters

The U/B model was used to assess lead exposure through soil ingestion. The model incorporates the major lead exposure pathways in deriving children's blood lead levels in Scenario 5 (Residential) in which exposures to children 0-6 years old are modeled. The trespasser scenario (Scenario 1) involves children 9-18 years old. The model is not applicable to this age group, and further, this age group is considered to be at lower risk. Therefore, this scenario is not modeled.

For this assessment, default values were used to represent background lead concentrations in air, drinking water and the diet. Additionally, the model's default values were used to represent respiratory rate, water ingestion rate, and the percent of lead absorption by the various exposure routes. The default values used are presented in Tables 2-16 through 2-18 for the three scenarios modeled.

The default value for lead in drinking water was used rather than the actual ground water geometric mean or maximum concentrations found on-site. Although residential receptors are assumed to use ground water as a source of potable water, the actual ground water data were not used because these levels (mean = 80 ug/l; maximum concentration = 4,800 ug/l) are well above the MCL value for lead (50 ug/l).

Levels of lead in drinking water of this magnitude make large contributions to blood lead (~6 µg/dl increase in blood lead at the geometric mean value for the site), and could thus obscure the importance of the soil lead contribution to blood lead. This is especially true in terms of the

percentage of children above the blood lead cut-off (10 µg/dl), since the individual contribution of the lead in ground water pathway at this site would cause a high percentage of children to already be above 10 µg/dl before factoring in the contribution from soil lead. Since the risk from soil lead is an important focus, this pathway was analyzed without the contribution due to on-site ground water.

This analysis then is most relevant to the residential scenario in which lead-impacted surface soils are accessible to young children, but the household drinking water supply is similar in lead content to that found nationally.

The site-specific factors put into this assessment are the soil lead concentration, the house dust lead concentration and the amount of soil/dust ingested per day. These values are also indicated as model inputs in Tables 2-16 through 2-18.

Three different soil lead levels were chosen for modeling: the maximum level found on-site, corresponding to the worst case exposure scenario; the geometric average level for the site, corresponding to the average case exposure scenario; the geometric average of a sub-portion of the site having somewhat elevated soil lead levels.

This last scenario corresponds to the case in which a home is built on or adjacent to the shore area that appears to be impacted. In this case, the geometric average of the four clustered surface soil samples which show elevated soil lead (relative to the remainder of the site), may represent the most likely average level for soil lead exposure.

The house dust lead level is modeled to be influenced by soil lead in the residential scenario because of the possibility that a house could be built on or adjacent to the impacted area. This close proximity to lead-impacted soils

can lead to substantial soil lead contributions to house dust lead through transport indoors via pets, shoes, clothing, etc. The model multiplies the soil lead level by 0.28 to express the increase in house dust lead due to soil lead.

The soil/house dust ingestion rate is modeled to be 200 mg/day for 1-6 year old children; this ingestion is modeled to comprise of 55% from house dust lead and 45% from soil lead.

Model Results

The model output for each soil lead concentration modeled is shown in Tables 2-16 to 2-18 and in Figures 2-1 to 2-3. The results are summarized in Table 2-19.

Table 2-19 summarizes the results in terms of the geometric average blood lead level for 0-6 year old children and the percentage of this population predicted to exceed a blood lead level of 10 $\mu\text{g}/\text{dl}$ (the model default for blood lead cut-off). This blood lead criteria is based upon the suggestion that neurological and perhaps hematological effects can occur in the vicinity of 10-15 $\mu\text{g}/\text{dl}$ (ATSDR, 1988). Therefore, an important parameter of population risk is the percentage of 0-6 year old children predicted to have blood lead levels in excess of 10 $\mu\text{g}/\text{dl}$.

The data (Table 2-19) show that children residing on the site and equally exposed to all on-site soils (geometric average soil lead for the entire site) have a low blood lead level (2.74 $\mu\text{g}/\text{dl}$) whose population distribution indicates that very few (0.01%) children would be above 10 $\mu\text{g}/\text{dl}$. However, when the geometric average for the lead-impacted zone is used, the predicted average blood lead is 8.22 $\mu\text{g}/\text{dl}$, with 27.4% greater than 10 $\mu\text{g}/\text{dl}$. The population average and percentage over 10 $\mu\text{g}/\text{dl}$ are substantially higher than

this when using the highest soil lead value found on-site in the model (worst case analysis).

These results indicate that soil lead levels at the impacted zone may be sufficient to elevate children's blood lead levels into an area of concern in the Residential Scenario. This applies both to the worst case and to the case in which homes are built on or adjacent to the impacted zone. However, the risk for elevated blood lead levels is low if homes are not built near the impacted zone such that children living in these homes are not preferentially exposed to these soils, and the soil from this zone has little opportunity to contribute to house dust lead.

- Adults

Table 2-14 presents a summary of the cancer risks by compound and exposure pathway for Scenario 5. The total cancer risk for adults residing on site ranges from $6.0\text{E-}03$ (average value) to $1.3\text{E-}02$ (maximum value), which is well above the acceptable level ($1\text{E-}06$ to $1\text{E-}04$). The major contributor to this risk is ingestion of inorganics in drinking water, including: arsenic (risk range of $5.9\text{E-}04$ to $1.8\text{E-}03$), beryllium (risk range of $1.1\text{E-}04$ to $6.5\text{E-}04$), vinyl chloride (risk range of $1.2\text{E-}04$ to $2.2\text{E-}04$), and total carcinogenic PAHs (risk range $4.3\text{E-}03$ to $1\text{E-}02$). As discussed for Scenario 4 (future commercial/industrial use), average concentrations of the carcinogenic PAHs were estimated using qualified data. That is, the data associated with PAHs is associated with uncertainties which are indicated by "U" (non-detect) or "UJ" (non-detect, but estimated SQL) designation. The other pathway that makes a substantive contribution to cancer risk is the ingestion of PAHs present in soil ($4.4\text{E-}05$ to $7.0\text{E-}04$).

Table 2-15 presents the range of hazard index ratios by compound and exposure pathway. The total HI range for all pathways is 5.0E+00 to 3.6E+01, which is considerably greater than the target value of 1E+00 for HI. Ingestion of chemicals in tap water, most importantly antimony, arsenic, cadmium, chromium, copper and zinc, accounted for the vast majority of the HI. Ingestion of metals in surface soil made a contribution of 8E-01 to the HI while all other pathways were considerably below this level.

Summary of Cancer and Non-Cancer Health Risks

This site currently contains elevated levels of certain key toxicants, which are responsible for driving the risk assessment. The residential scenario was associated with the greatest cancer risk and HI values, due largely to the ingestion of ground water (as tap water) which was absent from Scenarios 1, 2 and 3. Scenario 4 included the use of ground water as a potable drinking water source, however a shortened exposure duration and exposure frequency reduced the risks associated with this pathway for commercial/industrial use. In general, inhalation and dermal contact with contaminants were not major exposure pathways; soil ingestion was of importance in Scenario 5 (worst case), primarily due to PAHs, and in Scenario 3 due to antimony in subsurface soil, which elevated the HI.

The chemicals in ground water causing the greatest cancer risk are the carcinogenic PAHs (maximum risk of 1E-02 in adults), arsenic and beryllium. Exposure to PAHs in soil is also of importance in each scenario, and PAH contamination of surface soils was substantial at 7 of 15 locations (e.g., benzo(a)pyrene range at these locations was 1,000 to 16,000 ug/kg).

Seven carcinogenic PAH compounds, including benzo(a)pyrene, were included in the quantitative risk assessment. All were assigned the cancer slope

factor derived for benzo(a)pyrene, which is among the most potent members of this chemical class. Most carcinogenic members of this class have been shown to induce skin cancer upon topical administration, while the more heavily studied agent, benzo(a)pyrene, has also been shown to cause lung and stomach tumors (ATSDR, 1990). The seven carcinogenic PAH compounds were not detected in ground water but were included in the quantitative assessment because of one set of UJ qualified data (MW-6). The SQL in this case was low (10 ug/l) and this is below the CRQL. Thus, although the PAHs are a primary contributor to elevated cancer risk, there is significant uncertainty associated with the actual presence of these compounds in ground water. PAHs were not detected in the background (upgradient) monitoring well (MW-22) at an SQL of 10 ug/l.

Similar to the case for PAHs in ground water, vinyl chloride was associated with elevated cancer risk ($1E-04$ to $2E-04$, adults, Scenario 5), but was not actually detected in ground water. The UJ data qualifier was placed on all VOC data for one monitoring well (MW-3D) causing vinyl chloride to be included in the quantitative assessment.

Dermal cancer risk for PAHs was not calculated because of uncertainty regarding the carcinogenic potency of the agents by the dermal route. However, given the preponderance of evidence in rodents that these agents are carcinogenic by dermal exposure, it is likely that this analysis underestimates the cancer risk due to PAH compounds present in water and soil. The increase in cancer risk that could be associated with dermal exposure to PAHs in soil is not likely to be substantial since the dermal dosage to these agents was generally less than that received via oral exposure to PAHs in soil. Further, the dermal dose represents the absorbed dose, which is only 5% of the exposure dose for PAHs.

Exposure to arsenic in ground water is also of primary importance. Arsenic is a group "A" carcinogen, whose carcinogenic effects are most notable in the skin after oral absorption. While the arsenic oral slope factor for carcinogenic effects is based upon the evidence of human skin cancer, arsenic exposure by the oral route has also been associated with elevated cancer incidences in bladder, lung, liver, kidney and colon (EPA, 1991 - IRIS File). The carcinogenic potency of arsenic upon dermal exposure has not been quantitatively evaluated..

Arsenic was detected at all sampling locations, at a range of 2.1 to 89.4 ug/l, and a mean of 30 ug/l. Background (upgradient) arsenic in ground water at this site is 54 ug/l, and the range for the five NETC sites addressed in this risk assessment is 2-54 ug/l. Elevated arsenic concentrations were detected in numerous wells including MW-3S, MW-5, MW-7, MW-21 and MW-22. Thus, it appears that arsenic concentrations are elevated in ground water and that excess cancer risk due to arsenic ingestion may be site related.

Beryllium in ground water is the third primary component of excess cancer risk associated with future use of the McAllister Point Landfill. Beryllium is a Class B2 carcinogen (probable human carcinogen) whose most notable carcinogenic effects occur in the lung. Beryllium was detected in six out of ten well sampling locations at a range of 2-12.8 ug/l. The background beryllium concentration at this site is 1 ug/l, and for all NETC sites addressed in this report is 1-5.5 ug/l. Thus, it appears that elevated concentrations of beryllium in ground water and associated excess cancer risk may be site related.

The contaminants in ground water causing the greatest hazard index ratios are antimony, arsenic, cadmium, chromium, copper, manganese and zinc. Arsenic was discussed in light of cancer risks and will not be repeated here.

Antimony ingestion is associated with decreased longevity, fasting blood glucose levels and alteration of cholesterol levels. Antimony was detected in eight of ten well sampling locations at a range of 22-259 ug/l. Background levels for the five NETC sites addressed in this report range from 22-48 ug/l, with a site specific background of 22 ug/l. Thus, it appears that antimony levels are elevated at the site and that ingestion of ground water may pose a health risk. Antimony was detected eleven times out of twenty-eight subsurface sampling locations, with a range of 3.5-167 mg/kg. While this range exceeds U.S. background levels (<1-8.8 mg/kg), the exceedance can be attributed to only two samples (B-2 and B-9) detected at 56 and 167 mg/kg, respectively.

The critical effects associated with cadmium ingestion are proteinuria and renal damage in humans. Cadmium was detected in all monitoring wells and concentrations ranged from 3 to 57.1 ug/l. Background for all sites was reported as 3 ug/l. Thus, it appears that cadmium concentrations are elevated in the ground water, and ingestion of this water may result in a health risk.

Chromium is thought to be an essential nutrient in humans. Short term, high levels of chromium VI are irritating to the G.I. tract, and adverse effects in the kidney and liver may occur. Chromium was detected in four of ten monitoring wells, at a range of 16.9 to 248 ug/l. The background chromium concentration at the McAllister Point Landfill is 10 ug/l, while background for the five NETC sites is 8-121 ug/l. Thus, it appears that chromium is elevated in ground water and that excess noncancer health effects may be associated with the ingestion of ground water containing chromium.

The current drinking water standard for copper is 1.3 mg/l. Copper was detected in one half of the wells sampled at this site, with a range of concentration from 57.3 to 3160 ug/l. Background concentrations for the five

NETC sites range from not detected to 297 ug/l. The background at this site is 31 ug/l. Only one well contained copper concentrators which exceeded the current drinking water standard (MW-35; 3160 ug/l), suggesting that ingestion of copper at the site may not be of primary importance.

Chronic manganese ingestion has been shown to produce central nervous system effects. Manganese was detected in all monitoring wells at this site, primarily at concentrations exceeding site related background (1140 ug/l). When compared to background levels for all five NETC sites (1140-7650 ug/l) manganese appears to be elevated in ground water. Thus, ingestion of ground water containing elevated manganese is likely to contribute to adverse health effects.

Zinc ingestion has been shown to produce anemia in humans. Zinc was detected in nine of ten wells sampled, at a range of 168-12,100 ug/l. Background for the site and the range for the five NETC sites is 105 ug/l and 66.4-708 ug/l, respectively. Again, it appears that zinc concentrations are elevated in ground water and the estimates of risk are not likely to understate potential health hazards.

2.5.2 Qualitative Analysis of Risks

Selected compounds (see Table 2-4) were addressed qualitatively rather than quantitatively because compounds were lacking cancer slope factors or RfD values. It is not possible to include these cases in the quantitative analysis, and instead, the possible effect they could have on the assessment is discussed qualitatively. Few of the compounds missing reference toxicity values (either CPFs or RfDs) were not associated solely with data qualifiers ("U" or "UJ" designations) (Table 2-4). These compounds include:

- Inorganics
 - Cobalt
 - Copper
 - Lead
 - Nickel
 - Selenium
- Volatile Organics
 - Tetrachloroethene
- Semi-Volatiles
 - 1,4-Dichlorobenzene
 - Phenol
 - 2,4-Dichlorophenol
 - 2,4,5-Trichlorophenol
- Tentatively Identified Compounds

The potential impact associated with the omission of these compounds from the quantitative risk assessment is discussed below.

- Inorganics

Currently, no RfD for cobalt has been published by the EPA. Cobalt is an essential component of vitamin B12, which is required for the production of red blood cells (see Appendix F). The range of detection for soil sample results is 1.5 mg/kg - 28 mg/kg, as compared to a U.S. range in soil of 0.3-70 mg/kg. Although the average concentration of cobalt in soil is elevated over the average U.S. background concentration (Table 2-1, 2-2), the levels on-site are not out of a normal range. Therefore, a cobalt RfD is not expected to be crucial to the outcome of the risk assessment.

An inhalation RfD for copper is not available from EPA (see Appendix F). The range of detection of copper in soil is 11-6,070 mg/kg, which exceeds the U.S. background range for this metal. Similarly, calculated average concentrations of copper exceed reported U.S. average concentrations. Because copper has been shown to cause local G.I. irritation following ingestion, it is not practical to extrapolate from the oral route to the inhalation route.

Thus, the contribution of copper to health risks following inhalation is uncertain. However, it should be noted that doses and risks associated with inhalation of fugitive dusts are very low.

The EPA weight of evidence for the carcinogenicity of lead is "B2" - a probable human carcinogen; however, a quantitative risk estimate has not been provided (see Appendix F). Lead concentrations appear to be elevated in soil (Tables 2-1 and 2-2), such that some degree of concern over the lack of quantitative cancer risk is noted.

There are no oral or inhalation RfDs for nickel at this time (see Appendix F). The range of detection of nickel in soil is 2.7-105 mg/kg, which is well within the reported U.S. background range (Tables 2-1, 2-2). An RfD of $1\text{E-}02$ mg/kg/day has been derived in order to calculate a lifetime health advisory for nickel (EPA, 1987a). Comparison of this RfD to oral doses received during current or future use of the site indicate the omission of nickel from the quantitative assessment is not likely to underestimate risk.

Currently, no inhalation RfD for selenium has been published by the EPA (see Appendix F). The range of detection for soils is 0.33 mg/kg - 4.2 mg/kg, as compared to a U.S. background range of 0.1 - 3.9 mg/kg. Thus, levels on site appear to be slightly elevated and lack of a quantified dose-response relationship may have some impact on the outcome of the risk assessment. However, it should be noted that doses and risks associated with inhalation of fugitive dusts are very low.

- Volatile Organics

An inhalation RfD is not available for tetrachloroethene at this time (see Appendix F). Tetrachloroethene was detected in both surface and subsurface soils at low concentrations, ranging from 0.002-0.012 mg/kg, and 0.002-0.38

mg/kg, respectively. Derivation of an inhalation RfD from the oral RfD ($1\text{E-}2$ mg/kg/day) and comparison with inhalation dose estimates indicates that the absence of tetrachloroethene from the quantitative (inhalation) risk assessment is not likely to underestimate risk.

- Semi-Volatiles

Currently, no RfD for 1,4-dichlorobenzene has been published by the EPA (see Appendix F). 1,4-Dichlorobenzene was detected once out of ten possible ground water sampling locations at a trace concentration (10 ug/l), and was not detected in surface soil. The range of detection of 1,4-dichlorobenzene in subsurface soil is 0.05-2.2 mg/kg. The lifetime Health Advisory is 0.075 mg/l, from which an oral RfD of 0.1 mg/kg/day can be derived (EPA, 1987). Using this value to estimate non-cancer health risk from ingestion of ground water indicates that omission of 1,4-dichlorobenzene from the quantitative assessment is not likely to contribute to an underestimation of risk.

No inhalation RfD for phenol has been published by the EPA due to inadequate health effects data (see Appendix F). Phenol was not detected in surface soil, and thus is not of concern for Scenarios 1, 2, 4 and 5. Concentrations of phenol in subsurface soil were low, and ranged from 0.15-2.7 mg/kg. Extrapolation of the oral RfD ($6\text{E-}01$ mg/kg/day) to an inhalation RfD and use in estimating inhalation risk in Scenario 3 (future construction use) suggest the absence of phenol from the quantitative assessment is not likely to contribute to an underestimate of risk.

An inhalation RfD for 2,4-dichlorophenol has not been published by the EPA (see Appendix F). 2,4-Dichlorophenol was not detected in surface soil. Thus, omission from the quantitative assessment for Scenarios 1, 2, 4 and 5 is not likely to underestimate non-cancer health effects. In subsurface soil,

2,4-dichlorophenol was detected frequently and at low concentrations (range of 0.054-2.7 mg/kg). If an inhalation RfD were extrapolated from the oral RfD of $3\text{E-}03$ mg/kg/day, exposures to fugitive dusts (Scenario 3) carrying 2,4-dichlorophenol would not be expected to contribute significantly to the non-cancer risk assessment.

The health effects of 2,4,5-trichlorophenol were determined to be inadequate for the derivation of an inhalation RfD (see Appendix F). 2,4,5-Trichlorophenol was not detected in surface soil, and thus is not of concern for Scenarios 1, 2, 4 and 5. Concentrations in subsurface soil ranged from 0.11-14.0 mg/kg. Use of the oral RfD in estimating inhalation risk suggests that omission of 2,4,5-trichlorophenol from the quantitative risk assessment is not likely to underestimate risk.

Tentatively Identified Compounds (TICs)

TICs are not quantitatively addressed because their chemical identities were poorly characterized. In the vast majority of samples, the TICs are listed as "unknown". In the few isolated cases where a specific chemical is listed as a TIC, the levels are generally low (<1 mg/kg). Total TIC levels per soil sample range up to 100 mg/kg, but without a better indication of the contaminants which comprise the TIC listing, no qualitative or quantitative assessment can be made.

2.5.3 Uncertainty Assessment

- Site-Specific Uncertainty Factors

The scenarios developed for the site include exposures resulting from probable current use by trespassers and potential future use of the site as a future recreation, commercial/industrial and residential area. The risks

associated with these scenarios are conditional on these land uses occurring. Observations made during field investigations indicate that activities such as trespassing have occurred on the site, although the frequency of such activities are unknown. Thus, the uncertainty associated with the exposure frequency and duration for Scenario 1 may be large, and may contribute significantly to an overestimation of risk. Current zoning for the site is commercial/industrial, although there is some potential for the site to be used for recreational purposes. This uncertainty in future use of the site adds a degree of uncertainty to the risks associated with Scenario 2. Use of the site for commercial/industrial purposes is more likely, thus reducing the uncertainty associated with Scenarios 3 and 4. Finally, it is unlikely that the site would be developed for residential use. The uncertainty associated with this scenario (Scenario 5) is quite large and is likely to contribute significantly to an overestimation of risk associated with the site.

Additional uncertainty in the risk characterization may stem from exclusion of chemicals in the quantitative risk assessment. Chemicals which were not included in the quantitative risk assessment were excluded due to either lack of detection in the chemical analysis or as a consequence of missing toxicity data.

Chemicals with missing toxicity values are not expected to introduce a large degree of uncertainty into the risk estimates, as described in Section 2.6. Chemicals not detected on-site were omitted from the analysis on the basis that the samples taken include the worst portions of the site. There is uncertainty with regards to the amount of sampling that would be required to verify that the chemical concentrations used presently truly represent the geometric mean and maximum values.

Any chemicals expected to contribute a significant uncertainty to the assessment of risk were addressed qualitatively in Section 2.4.2. Briefly, the exclusion of these compounds is not likely to underestimate the cumulative hazard index ratio due to low concentrations and doses.

Table 2-20 summarizes the exposure pathways considered for the risk assessment, and reasons for exclusion or inclusion. Ingestion of ground water as a current use scenario was not addressed as no wells are located in the vicinity of the site.

Two models were used to characterize exposure point concentrations. The first, a model used to estimate concentrations of chemicals in fugitive dust, was taken from AP-42 (EPA, 1988) (see Appendix A). The key model assumptions include the time frame during which the construction on site is likely to take place and the use of a yearly average wind speed. The potential impact of these assumptions will be to underestimate risk if construction occurs for a longer period of time than originally estimated, or, if daily wind speeds exceed the annual average wind speed. The second model, volatilization of chemicals during home use of ground water (i.e., showering) (see Appendix A) was taken from Andelman (1985). A key assumption for this model is likely to include the fraction of contaminant volatilized, which is assumed to be 0.9 (90%). This assumption is likely to overpredict, rather than underpredict, risk.

As indicated in Section 2.5.1, the primary route of exposure for Scenarios 1, 2 and 3 is incidental ingestion of soil, while ingestion of ground water is the primary route of exposure for Scenarios 4 and 5. Site data gaps which resulted in the use of conservative assumptions for Scenarios 1 and 2 include the frequency with which children trespass on the site or use the site for recreational purposes. Similarly, the exposure duration for construction

workers was based on a conservative assumption, such that the risk estimate may be overestimated. Finally, risks associated with ingestion of ground water rely on the 90th percentile ingestion rate (2 l/day) (or one half this value for consumption during a work day), and this may drive the risk estimate for this pathway.

Some significant uncertainties exist in the data used for this site. In most cases these uncertainties are likely to overestimate, rather than underestimate, the risk.

A few examples of data uncertainties include:

- Chemicals detected infrequently in all media were assumed to occur across the site at an average or maximum detected concentration.
 - "UJ" data (i.e., resulting from matrix effects) were included as the SQL in calculations of the average, and considered as potential locations of contamination.
 - "U" data (non-detect values) were included as one half the SQL, used in calculation of the average, and considered as potential locations of contamination.
 - Uncertainties in background sampling locations, particularly with regard to inorganic compounds, disallowed exclusion of compounds which may occur naturally at the site.
- Uncertainty Surrounding Cancer and Non-Cancer Risks

For the risk estimation of cancer and of chronic non-cancer health effects, risks from all exposure pathways and for all chemicals have been summed to yield the total site risk for a given receptor. This is a conservative approach, since, in general, different chemicals do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, chemicals may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for chemical transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that

certain chemicals can be synergistic such as is the case when a promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator. The uncertainties surrounding these possibilities are discussed below for the chemicals found on-site.

Cancer Risks

The major uncertainty regarding cancer risk is the degree of exposure possible to PAHs in drinking water. While PAHs in ground water contributed more to cancer risk than any other agent or pathway in Scenarios 4 and 5, the carcinogenic PAHs were not actually detected in ground water. Their inclusion in the quantitative assessment is based upon UJ qualified data, which indicates that the chemical was not detected but there is uncertainty regarding the sensitivity of the analytical test (SQL value). This uncertainty drives the risk assessment and thus is worth discussing in greater detail. On one hand it would appear unlikely that carcinogenic PAHs were actually in ground water since this uncertainty (UJ data) occurred in only 1 of 10 monitoring wells, and at the other nine monitoring wells none of these agents were detected. However, other PAHs (non-carcinogenic) were detected in several of the monitoring wells (e.g., naphthalene in three wells, range = 3-240 ug/l; phenanthrene in two wells, range = 3-21 ug/l; fluorene in two wells, range = 3-25 ug/l). Since the carcinogenic and non-carcinogenic PAHs are often found together in environmental matrices, it is not unexpected that some level of the carcinogenic PAHs is also present in ground water. Thus, while there is no firm basis to conclude that cancer risks from PAHs in ground water are possible at this site, this possibility cannot be eliminated. Inclusion of the one set of UJ data highlights this possibility, but it does not portray the likely magnitude of such possible risks, which currently cannot be determined.

PAHs in surface soil make a substantive contribution to cancer risk in Scenario 5, with risk levels of $4E-05$ in the average case to $7E-04$ in the worst case. Carcinogenic PAHs were elevated at a variety of surface soil locations. Thus, it is probable that should the modeled dust exposure behaviors occur on this site, extensive PAH exposure could occur. The data suggest that a substantial portion of the site could be affected (7 of 15 sampled locations). Additional soil sampling would be useful to further define the geographic extent of this contamination.

Benzene was detected in ground water at three monitoring wells, but only at low concentrations. Its presence in ground water could conceivably contribute to cancer risk due to inhalation during bathing and ingestion exposures. The oral cancer slope factor is extrapolated from the inhalation value since no oral-specific value has been derived. This dose route extrapolation should not introduce a large degree of uncertainty since the target organ for benzene-induced carcinogenesis is systemic (hematopoietic system) rather than local to the portal of entry. However, dosimetric differences are possible when switching dose route (e.g., oral exposure is associated with a first pass liver effect), which could affect cancer potency and thus risk from oral exposure. Since benzene exposure was not associated with a large portion of the cancer risk at this site, this uncertainty does not appear to be a major factor.

Interactions between carcinogens present at this site may both lead to enhanced and diminished carcinogenic responses. Arsenic, which is responsible for some elevation in cancer risk on-site, is at most only weakly mutagenic, but its carcinogenic effects appear to be mediated through clastogenic effects (ATSDR, 1989). Arsenic-induced chromosomal damage may be due to an impairment of DNA replication or repair, and this effect could facilitate the genotoxic

effects of other agents (ATSDR, 1989). Arsenic has been shown to greatly increase the mutagenic effects of direct-acting agents such as UV radiation, and alkylating agents. Further, arsenic appears to increase the production of lung tumors caused by benzo(a)pyrene, and is generally considered to have promotional activity (ATSDR, 1989). The target organ for arsenic's effects after oral ingestion (inhalation of arsenic is not a major concern at this site) is primarily the skin, but elevations in bladder, liver and lung cancer in humans exposed orally to arsenic have also been reported (EPA, 1991 - IRIS File; ATSDR, 1989). Therefore, it appears that arsenic might be able to enhance the carcinogenic action of other genotoxic agents at a variety of target sites.

Of the other carcinogens of concern found on-site, only the group of PAH compounds can be classified as being genotoxic. The PAHs were responsible for a majority of the elevated risk on site. Like arsenic, the PAH compounds exert genotoxic and carcinogenic effects in skin and at internal organs (ATSDR, 1990). The finding that arsenic can enhance lung tumor production by benzo(a)pyrene (ATSDR, 1989) supports the concept that a synergistic action is possible, particularly since arsenic and PAH compounds are found together in soil. Since the skin is an important target site for both the PAH compounds and arsenic, the synergistic effect might be most probable in the skin. Exposure to the skin may occur both directly by dermal contact, and after ingestion of soil or drinking water.

It is of note that beryllium, another carcinogenic metal found in soil, also can produce skin tumors upon oral exposure.

There is evidence that arsenic's toxic, cytogenetic, and carcinogenic effects can be antagonized by selenium, possibly through an interaction at the level of biliary excretion (ATSDR, 1989).

The carcinogenic PAH compounds are considered to, in general, act similarly with respect to mechanism of action and target organ. However, as a mixture their effects may not be strictly additive due to the potential for co-carcinogenic and antagonistic effects (ATSDR, 1990). These effects appear to be mediated primarily through interference with each other's metabolism - either activation or detoxification, and by inducing, activating or detoxifying enzymes. The difference between antagonism, synergism and additivity of carcinogenic effects appears to depend upon the timing of the dosage of the different PAHs, the ratio of the different agents administered, and the exact agents involved (Baird, 1984; Slaga, 1979; Van Duren, 1976). These factors are too complex to allow prediction of the likely outcome from the interaction of PAH compounds at this site. However, this factor does introduce uncertainty in the calculation of cancer risks.

Non-Cancer Effects

In several instances, chemicals in soil elevated the HI because of soil ingestion. In the worst case analysis of Scenario 5, ingestion of antimony, copper and zinc each caused the HI to exceed 1E+00. However, in the average case these chemicals alone, or in combination, did not elevate HI. In Scenario 3, a construction scenario where the ingestion rate is set at 480 mg/day, the hazard quotient index maximum was calculated to be 2.0E+00. This value is based upon the maximum detected value of antimony which was 167 mg/kg. There was only one other location out of 28 sampling locations where the antimony concentration in soil exceeded the U.S. background levels (≤ 8.8 mg/kg). The extent to which the contamination of antimony from these two high level sites would effect construction workers at the McAllister site is not known. However, given the nature of construction tasks (the moving, mixing

and diluting of contaminated soils), the chronic, non-cancer effects attributed to antimony on construction workers is likely to be below that predicted by the worst case analysis. It should be noted that the HI was less than 1E+00 in the average case in this scenario.

By far the majority of health hazard found on-site at McAllister Point is associated with the potential ingestion of metals in drinking water, including antimony, arsenic, cadmium, chromium, copper, manganese, mercury and zinc. Of these chemicals, antimony, arsenic and manganese were each capable of driving the health hazard index ratio above 1E+00 in the average case when the mean concentration of each chemical was used.

These elevations in HI are associated with elevations in ground water concentrations, as discussed above. Therefore, the major uncertainty associated with non-cancer risks at this site is the potential for ground water to be used as potable water. Since the ground water at this site is apparently brackish and thus not suitable for use as potable water, these contributions to HI may not be very likely.

The elevations in HI (above 1E+00) at this site were generally not caused by adding individual HIs for different compounds. Several metals were capable of elevating the HI on their own. Therefore, considerations of whether it is appropriate to summate HIs stemming from non-cancer effects that occur in different tissues for different chemicals do not increase the uncertainty in this analysis.

Uncertainties In The Derivation of Toxicity Values

In numerous cases in which a toxicity value was available for one exposure route but not another, a dose route extrapolation was performed. These extrapolations were utilized to go between the oral and inhalation routes of

exposure if the toxic/carcinogenic effects were systemic rather than local. The compounds for which this was done are noted in Appendix F. The oral to inhalation dose route extrapolation can underestimate potency from inhalation exposure if the chemical is irritating, insoluble, slowly absorbed or highly reactive. Under these conditions, the dose to specific lung regions may be greater than that to the G.I. tract or internal organs, creating the possibility that the lung would be at greater risk. At this site, this possibility is greatest for the oral-to-inhalation extrapolation of RfD values for the metals arsenic, beryllium, nickel and zinc. However, inhalation of these metals was due to the dust inhalation pathway which was a minor exposure route. Therefore, underestimation of toxicity values for inhalation exposure should not have a large effect on the outcome of this risk assessment.

A form of dose route extrapolation used in this assessment was the use of oral toxicity values for dermal exposure. This extrapolation was utilized for all compounds except PAH compounds, whose potential for dermal effects was discussed.

A correction factor was not used for dermal RfDs and slope factors to take into account the difference between absorbed vs exposure doses in oral vs dermal data, based on guidance from EPA Region I. In general, the oral toxicity values are based upon an exposure dose, while the dermal doses for the modeled pathways are in terms of an absorbed dose. The absence of the use of such a correction factor provides a less conservative approach in estimating risk.

Assignment of the benzo(a)pyrene cancer slope factors to other carcinogenic PAH compounds is likely to create a considerable overestimate of risk. Benzo(a)pyrene is one of the most potent PAH compounds, and of the others on-site, only dibenzo(a)anthracene has a similar carcinogenic potency

(Rugen, 1989; Clement, 1987; EPA, 1985). Chrysene's potency appears to be ~200 fold below that for benzo(a)pyrene. The data upon which these relative potency estimates are based are taken from primarily dermal studies in which the development of skin tumors was studied. The degree of uncertainty in extrapolating these results to the oral route of exposure in order to adjust the oral slope factor is not known. However, these data are applicable to considerations of the cancer risk from dermal exposure. The overestimation created by using the benzo(a)pyrene slope factor as a surrogate for the other PAH compounds partially offsets the possible underestimation of risk from dermal exposure caused by not adequately characterizing the dermal exposure dose to arsenic and PAH compounds, as described above.

The use of the RfD for naphthalene for all PAHs not currently assigned an RfD is a conservative approach recommended by EPA, Region I (EPA, 1989). Naphthalene's chemical and physical properties are unlike the group of PAHs, suggesting the existence of uncertainty in the use of the toxicity values for naphthalene.

3.0 MELVILLE NORTH LANDFILL - SITE 02

The Melville North Landfill site is situated at the northern end of the NETC facility in a low-lying, wetland-type area along the shoreline of Narragansett Bay. The site encompasses approximately 10 acres and a portion of it was used as a landfill for a period of time following World War II, until 1955. Currently, the site is not in use, but the Navy has sold the land to a private party who intends to build a commercial/industrial marina.

3.1 Identification of Chemicals of Potential Concern

3.1.1 Data Collection

A geophysical survey was conducted prior to initiation of sampling activities. Fifteen surface soil samples were collected from on-site locations. On-site samples were collected outside of suspected fill areas, to characterize undisturbed site conditions. An area of oily surficial deposits were chemically characterized in previous site investigations.

Seven test pits were excavated to investigate former lagoon locations and geophysical anomalies. Soil samples were collected from four of the test pits. Thirteen test borings and five well borings were also advanced at various locations throughout the site. Two to three samples were generally collected from each boring located in the fill area: one from the fill material, one from immediately beneath the fill material, and one at the water table. One to two soil samples were collected from other soil borings. Observed fill materials are generally characterized as consisting of soil and gravel fill, scrap metal debris, and burned wood debris.

Four on-site monitoring wells and one off-site, upgradient monitoring well were sampled in July 1990. Petroleum odors and sheen were present in one

on-site well (MW-4) and an oil layer was identified in another on-site well (MW-3).

Three sediment samples were collected from a wetlands area just north of the site.

3.1.2 Data Evaluation

As detailed in the RI report, the site was used as a landfill for at least the period following World War II until 1955 and landfill wastes remain in-place on-site. Field studies have revealed the presence of numerous organic and inorganic contaminants in the surface and subsurface soils and ground water.

In order to organize the data into a form manageable and appropriate for the baseline risk assessment the following steps were followed during the data evaluation process as described by EPA (1989) and EPA (1989a):

- 1) Gather and sort all data by medium (surface soil, and subsurface soil and ground water), and determine the spatial distribution of detects and non-detects;
- 2) Evaluate methods of analysis;
- 3) Evaluate the sample quantitation limits;
- 4) Evaluate the data qualifiers and codes;
- 5) Evaluate blank data;
- 6) Evaluate tentatively identified compounds (TIC's);
- 7) Evaluate background data;
- 8) Develop data sets by medium; and
- 9) Develop a set of chemicals of potential concern from the entire data set.

Briefly, the specific methods used for Site 02 include the following, which correlate with the previously described steps.

- 1) All analytical data was initially sorted by media (surface soil, subsurface soil and ground water). Near shore soil samples were included in the analyses of surface soil. Surface water samples (e.g., Narragansett Bay) were not taken in Phase I.
- 2) An evaluation of analytical methods was not considered to be necessary as all data used was analyzed by EPA's Superfund Contract Laboratory Program (CLP) procedures;
- 3) Unusually high sample quantitation limits (SQL's) were not commonly reported in any of the matrices analyzed. This indicates that in most cases, matrix or chemical interferences in the analytical determinations did not cause a loss of sensitivity at this site. One-half of the SQL was used for a non-detectable reading if there was evidence that the chemical is present in that medium. However, for non-detects where it appeared more likely that the chemical could be present at a value greater than 1/2 the SQL, the entire SQL was used. Consideration as to the use of one-half the SQL included extent and degree of contamination or concentration within each media and potential for migration between media. Similarly, if a chemical was not detected in a single medium, transport and fate information was used to determine the likelihood of low chemical contamination (below the SQL) in that particular medium;
- 4) Data validation qualifiers were assessed during the data evaluation process. As indicated in EPA guidance (EPA, 1989 and 1989a), data qualified with U, J or UJ qualifiers were used in the quantitative risk assessment when appropriate. Chemical data qualified with a "U" (not detected) was used as one half the SQL. Non-detect values were not ignored based on the presence of "hits" within the same media or uncertainty associated with analysis (i.e., "UJ" qualified data);
- 5) Field and laboratory blanks were used to segregate actual site contamination from cross contamination from field or laboratory procedures. As indicated in EPA (1989) sample results were considered positive only if concentrations exceeded ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a chemical that is not considered a common laboratory contaminant;
- 6) Tentatively identified compounds (TICs) were reported in soil samples across the site. Approximately one half of the TICs ranged from relatively low concentrations (100 µg/kg) up to 10,000 µg/kg. TICs were reported in the majority of subsurface soil samples with a very wide range of concentrations (3 µg/kg up to 400,000 µg/kg). Of the five monitor wells sampled, all contained TICs with the exception of MW-5, located upgradient of the landfill proper. In general, the number of TICs (ranging from 3 to 20), and the concentrations (6 µg/l to 780 µg/l), were low. Due to the uncertainty associated with the quantitative and qualitative nature of these TICs, only a qualitative assessment of risk associated with exposure was included in this assessment;

- 7) Background soil sampling locations were identified for the Melville North Landfill site (Site 02). Boring MO-5 (0-2') was identified as a background surface sampling location and was used for comparison purposes. National soil background levels (i.e., naturally occurring levels) were also used as a screening method to evaluate non-site related chemicals or commonly encountered, naturally occurring chemicals. Monitor well MW-5 was located upgradient of the landfill portion of the site and was used for comparison purposes to determine migration of contaminants in ground water; and,
- 8) Tables 3-1 through 3-3 provide the chemicals and concentrations sampled in surface soils, subsurface soils, and ground water respectively. Sediment samples taken at near shoreline locations were considered as surface soil samples. Table 3-4 provides a summary of chemicals of potential concern in each media.

3.1.3 Summary of Surface Soil Data

Table 3-1 presents a summary of the analytical data associated with chemicals detected in surface soil, organized by class including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class of chemicals is discussed in detail below.

- Inorganics

All of the inorganics analyzed were detected at a minimum of one of twenty locations on site. SQL's for inorganics were not unusually high. Comparisons to U.S. background (naturally occurring) levels (see Table 3-1) indicate a general trend of elevated concentrations of antimony, arsenic, cobalt, copper, lead, mercury, nickel and zinc.

- Volatile Organics

Of the thirty-five volatile organics analyzed for in Table 3-1, only two (2-butanone and methylene chloride) were not detected at any of the twenty sampling locations. Eight VOCs were detected at a frequency of 6/20 or greater including 1,1,2,2-tetrachloroethane (7/20), 4-methyl-2-pentanone

(8/20), chlorobenzene (7/20), ethylbenzene (7/20), styrene (7/20), tetrachlorethene (8/20), toluene (8/20) and xylenes (7/20).

- Semi-Volatile Organics

Of the sixty-five semi-volatile organics analyzed for in surface soil and listed in Table 3-1, forty-four were not detected at any of the twenty sampling locations.

Polycyclic aromatic hydrocarbons (PAHs) detected at fourteen or more of the twenty sampling locations include benzo(a)anthracene (15/20), benzo(a)pyrene (14/20), benzo(b)fluoranthene (15/20), benzo(k)fluoranthene (14/20), chrysene (16/20), fluoranthene (17/20), phenanthrene (15/20) and pyrene (17/20). The concentrations of these PAHs ranged from below the sample quantitation limit (0.022 mg/kg for dibenzo(a,h)anthracene) to 15.0 mg/kg (for pyrene and fluoranthene). All other PAHs were detected at a frequency of 8/20 or less. With the exception of di-n-butylphthalate (1/20 - detected below the SQL), phthalate esters were not detected in surface soils. No unusually high SQL's were detected.

No naturally occurring levels were available for comparison with on site concentrations.

- Pesticides/PCBs

Only the pesticides 4,4'-DDD (1/20), 4,4'-DDE (12/20) and 4,4'-DDT (15/20) were detected on site. The range of detected concentrations were low, either equal to or below SQL's for 4,4'-DDD and 4,4'-DDE. The detected concentration of 4,4'-DDT was slightly higher than the SQL (.45 mg/kg) at SS-7. Of the PCBs analyzed for, only Aroclor-1260 and Aroclor-1254 were detected on-site, at

7/20 and 1/20 locations, respectively. The detected concentrations ranged from below the SQL (.043 mg/kg at SS-12) to 8.0 mg/kg at SS-1 for Aroclor-1260.

3.1.4 Summary of Subsurface Soil Data

Table 3-2 presents a summary of the analytical data associated with chemicals detected in subsurface soil (specifically, test pit and soil boring samples), organized by chemical class, including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class is discussed in detail as follows. Depths to twelve feet were used in the risk assessment based on potential site uses.

- Inorganics

Most inorganics were detected at a frequency of 33/34 or 34/34 (see Table 3-2). Exceptions include antimony (22/34), beryllium (32/34), cadmium (25/34), mercury (16/34), selenium (19/34), silver (15/34), sodium (23/34), thallium (27/34) and cyanide (6/34). Of these inorganics, only thallium was detected solely on the basis of qualified (UJ) data. Comparison to U.S. background (naturally occurring) levels (see Table 3-2) indicates a general trend of elevated concentrations of antimony, arsenic, cadmium, cobalt, lead, manganese, mercury, nickel, vanadium and zinc.

- Volatile Organics

Of the volatile organics (VOCs) analyzed, only methylene chloride was not detected at any of the thirty-six locations. Eight VOCs were detected at ten or more locations, including carbon tetrachloride (10/36), 2-hexanone (10/36), 4-methyl-2-pentanone (10/36), chlorobenzene (12/36), ethylbenzene (12/36), toluene (10/36), xylenes (13/36) and tetrachloroethene (10/36). Of these

VOCs, only data for chlorobenzene, ethylbenzene, toluene and xylene contained "hits", that is, data not associated with data qualifiers (e.g. "UJ" data).

No naturally occurring levels were available for comparison with on site concentrations of VOCs in subsurface soils.

- Semi-Volatile Organics

Of the sixty-five semi-volatile organics listed in Table 3-2 for subsurface soil, fifteen were not detected at any of thirty-six (36) locations on site. Furthermore, five compounds were detected only once (out of thirty-six possible locations) and nineteen were detected only twice. Of these twenty-four compounds, all were detected at low concentrations (i.e., close to or less than the detection limit). Polycyclic aromatic hydrocarbons (PAHs) detected at more than half of the thirty-six locations include benzo(a)anthracene (20/36), benzo(a)pyrene (21/36), benzo(b)fluoranthene (19/36), benzo(k)fluoranthene (19/36), chrysene (22/36), fluoranthene (24/36), phenanthrene (23/36) and pyrene (25/36). The range of detection for these PAHs was 0.044-28.0 mg/kg. Seven other PAHs detected at a frequency of 25-50% at the 36 locations included benzo(ghi)perylene, indeno(123cd)pyrene, acenaphthene, anthracene, dibenzo(a,h)anthracene, naphthalene and 2-methylnaphthalene. Bis(2-chloroethyl)ether was detected at 10/36 locations. However, these data points are not clear hits but rather were qualified ("UJ") data. Phthalate esters were detected infrequently. Di-n-octylphthalate, the most frequently detected phthalate ester, was detected at 5/36 locations at concentrations within the range of the SQL.

Unusually high SQL's occurred occasionally in subsurface soil samples, particularly in boring sample (M04-1) with an SQL equal to 45,000 µg/kg for phenolic compounds. No visual contamination was noted in this sample.

No naturally occurring levels were available for comparison with on site concentrations.

Pesticides/PCBs

Four pesticides were detected in subsurface soils, all at concentrations below the detection limits, including 4,4'-DDD (1/36), 4,4'-DDE (2/36), 4,4'-DDT (5/36) and aldrin (1/36). Two PCBs were detected in subsurface soil. Aroclor-1254 was found at 6/36 locations at levels equal to or below the detection limits. Aroclor-1260 was detected at 5 of 36 locations at levels equal to the detection limit ranging to one order of magnitude greater than the detection limit.

3.1.5 Summary of Monitor Well Data

Table 3-3 presents a summary of the analytical data associated with compounds detected in a single round of ground water monitoring. Each class of chemicals is discussed in detail below.

- Inorganics

Several inorganics were not detected at any of five sampling locations. Those inorganics include antimony, cyanide, selenium and silver. Inorganics detected at a frequency of 100% include aluminum, arsenic, barium, calcium, copper, iron, lead, magnesium, manganese, potassium, sodium, thallium and zinc.

Comparison of detected concentrations of inorganics in ground water to site background levels (upgradient MW-5) indicated a general trend of elevated concentrations for antimony, barium, cadmium, copper, lead, manganese, mercury, vanadium and zinc.

- Volatile Organics

With the exception of methylene chloride, all volatile organic compounds were detected at a minimum of one of five possible sampling locations. The most frequently detected VOCs include benzene and chlorobenzene, which were each detected three times out of five possible sample locations. In general, concentrations of VOCs were low (near or below the SQL) and data was associated with qualifiers (U or UJ). Data for benzene, chloroethane, ethylbenzene, toluene and xylenes were not associated with any qualifiers, and in general, exceeded SQL's.

- Semi-Volatile Organics

Of the sixty-five semi-volatile organics analyzed for in the ground water samples and listed in Table 3-3, only nine were detected at any of the five sampling locations. These include 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2-methylnaphthalene, acenaphthene, anthracene, bis(2-ethylhexyl)phthalate, naphthalene, phenanthrene and pyrene. These compounds were detected as "hits" (unqualified detectable concentrations) at a frequency of one or two of five sample locations.

- Pesticides/PCBs

Gamma-BHC and Aroclor-1260 were the only pesticide or PCB compounds, respectively, detected in ground water. Gamma-BHC was detected at one location while Aroclor-1260 was detected at two of five sampling locations.

3.1.6 Selection of Chemicals of Concern

Table 3-4 presents a summary of contaminants in all media sampled (as a range of detection). Chemicals carried through the quantitative risk

assessment are marked with a single asterisk (*) to the right of the chemical name. Chemicals discussed in the qualitative risk assessment are marked with two asterisks (**) to the right of the chemical name. Those chemicals addressed both quantitatively and qualitatively are marked with 3 asterisks (***). Chemicals detected on site and associated completely with data qualifiers ("U" or "UJ" designations) are noted accordingly. Finally, contaminants of concern for this site are labeled in Table 3-4.

Chemicals of potential concern were selected from Tables 3-1 through 3-3 based upon their presence in a matrix and their potential to produce toxic effects. All chemicals positively identified in a matrix are included as chemicals of concern, and the associated risks are quantitated if cancer potency factors and RfD values are available. If these are unavailable, then the chemical's potential to produce adverse health impacts is considered for qualitative assessment.

Chemicals of potential concern are also those with "UJ" qualified data because of the uncertainty surrounding the SQL and thus the sensitivity of the analysis. Much of this uncertainty is removed if "UJ" data are the rare exception rather than the rule for a chemical, and there are no other sampling locations where the chemical was detected in that matrix. Further, if the reported SQL is not unusually high and if there are not a priori reasons to suspect that the "UJ" data are in a contaminated zone (e.g., other "hits" in the matrix, site history, visual/odorous indicators), then it is appropriate to treat the data point as not detected and thus exclude it from the quantitative risk assessment.

Some of the chemicals of potential concern listed in Table 3-4 were selected because of "UJ" data. The number of samples collected in each matrix was not always large, and thus there is low confidence that the one or several

"UJ" samples represent clear evidence of chemical absence in that matrix. Chemicals of potential concern solely because of "UJ" data were included in the risk assessment only if they are carcinogens. Thus, the uncertainty surrounding the "UJ" data is handled by inclusion of these data in the quantitative risk assessment for carcinogens. In cases where "UJ" data are included in the quantitative assessment, the SQL (not one-half the SQL) was used because of the probability that the SQL was underestimated in these samples.

3.2 Contaminant Fate and Transport

This section of the risk assessment evaluates the fate and transport of contaminants associated with the site and provides an indication of future contaminant movement. Section 3.1 outlined the occurrence of contamination across the site in surface soil, subsurface soil and ground water. Observed contamination consists mainly of: numerous inorganics, VOCs, PAHs and DDT (or breakdown products) in surface soil; numerous inorganics, VOCs, PAHs, DDT (or breakdown products) and PCBs in subsurface soil; and, inorganics, and few VOCs in ground water.

3.2.1 Potential Routes of Migration

To determine the fate of contaminants of potential concern at the site, information on the physical/chemical and environmental fate properties was collected for site contaminants. This information is presented in Appendix G for selected contaminants of concern. Several of the environmental media studied have the potential for off-site migration, primarily surface soils and ground water. Subsurface soils are not likely to be at risk of transport off-site unless exposed by excavation. Although the subsurface soils contain

several chemicals of concern, the mode of transport of the chemicals would be primarily through leaching and ground water transport.

Contaminants in surface soils can migrate or be carried from the site by surface runoff (resulting from precipitation), by the wind in the form of fine particulates sorbed to windblown dust, and by users of the site via vehicle tires, shoes, etc. In addition, contaminants can move from the surface soils (leaving the soils in place) through leaching by infiltration of precipitation and transport by ground water, and volatilization to ambient air. Finally, transport of contaminants to plants or animals which may potentially be consumed by humans is a possible route of migration.

3.2.2 Contaminant Distribution and Observed Migration

The following section examines the contaminants present across the site, (also discussed in Section 3.1), in combination with the migration pathways, to provide an understanding of contaminant persistence and migration at the site. The discussions below are presented with respect to contaminant or contaminant group. Contaminants observed in the environmental samples collected from the site include volatile organic compounds, semi-volatile organic compounds, PCBs, pesticides, and inorganics.

Inorganic Analytes

Many metals have an affinity for soils (particularly clay particles and organic matter in soils) which reduces their mobility. Under extremes of pH, some metals can be rendered mobile. The presence of the inorganic analytes, particularly the naturally occurring elements, must be examined in the context of natural background concentrations, as presented in Tables 3-1 and 3-2. The analytes which appeared elevated above U.S. background surface soil levels in

one or more samples are: antimony, arsenic, cobalt, copper, lead, mercury and nickel.

The analytes which appeared elevated above background in subsurface soil samples include antimony, barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium and zinc.

All inorganics with the exception of antimony, cyanide, selenium and silver were detected in on-site ground water, suggesting migration has occurred from soils. Comparison of inorganic concentrations in ground water on-site to upgradient concentrations indicates that a general trend of elevated concentrations occurs for all inorganics with the exception of aluminum, arsenic, beryllium, chromium, cobalt and nickel. Well locations made it difficult to examine the potential migration of inorganics off-site. However, a comparison of MW-1 (western edge of site) and MW-2 (central location upgradient from MW-1) does not show a trend of inorganics migrating off-site.

Volatile Organic Compounds

Most volatile organic compounds (VOCs) were detected in soils on-site, with the exception of methylene chloride. In general, concentrations of VOCs were low (near the SQL) with the exception of acetone (0.24 - 6.2 mg/kg), ethylbenzene (0.006 - 2.3 mg/kg) and xylenes (0.003 - 11.0 mg/kg). Each VOC was detected in at least one monitoring well (again, with the exception of methylene chloride), but data was associated with data qualifiers. VOCs detected at elevated concentrations and not qualified during data validation include benzene (3 - 49 µg/l), chloroethane (10 - 50 µg/l), ethylbenzene (5 - 44 µg/l), toluene (5 - 6 µg/l), and xylenes (5 - 110 µg/l). The principal mechanism for the natural removal of aromatic VOCs is through volatilization

(EPA, 1979). Vapor pressures (@ approximately 20°C) of the aromatic hydrocarbons range from 1 to 362 mm Hg and Henry's Law Constants range from 3.97×10^{-5} to 3.84×10^{-1} atm-m³/mol. The role of biodegradation in the natural attenuation of these compounds is compound specific. Similarly the role of adsorption is compound specific (e.g. acetone has little tendency to be retained by soils); the amount adsorbed is highly related to the amount of organic carbon in the soil and is represented numerically by the organic carbon/water partition coefficient (K_{OC}). The compounds with higher K_{OC} would be preferably partitioned to organic matter in soils and thus would be less likely to be leached from the soils and transported to the ground water. Some aromatic hydrocarbons are highly mobile. Benzene, for example, has a moderate solubility (greater than 1,000 mg/kg) and low K_{OC} (83 ml/g). Therefore, benzene, because of its tendency to volatilize and biodegrade, would be mobile but would not be expected to be very persistent in the environment. Conversely, xylenes, with their lower solubility (198 mg/kg) and higher K_{OC} (240 ml/g), would not be as mobile as benzene, but would be more persistent in the environment as they would tend to sorb to soil particles.

Subsurface soils from test pits and borings contained many aromatic hydrocarbons, generally at low concentrations. Based on frequency of detection and concentration, the subsurface soils are contaminated primarily with xylenes, ethylbenzene and acetone. In particular, acetone has a low K_{OC} value and is extremely soluble in water (100,000 mg/l for acetone). These properties suggest that acetone is likely to leach downward through soils to the ground water.

VOCs were not consistently detected in surface soil. The most frequently detected VOCs (4-methyl-2-pentanone, toluene and tetrachloroethene) were detected at low concentrations, as were the less frequently detected VOCs.

Based on the mobility and water solubility of these VOCs and the history of the site as a landfill, it is not unusual that increasing patterns of detection were found in subsurface soils.

Aromatic and chlorinated hydrocarbons were present in many ground water samples. VOCs noted above trace concentrations (greater than the SQL) in ground water samples included benzene, ethylbenzene and xylenes. Of the VOCs detected in the ground water samples, xylenes were found at the highest concentrations (up to 110 µg/l). The chemical/physical and environmental fate data indicate that these hydrocarbons are expected to migrate downward in soils to ground water.

Ground water beneath the site exits the site primarily to the west, both as shallow and deep ground water and connects hydraulically with Narragansett Bay. Contamination present in monitoring wells MW-1, MW-3, and MW-4 is considered to be indicative of migration of contaminants in ground water off-site. Examination of patterns of VOC occurrence in these wells indicates that some migration of VOCs may be occurring. For example, detectable concentrations of most VOCs were found in MW-1 although concentrations were very low (at or below the detection limits). However, data from an on-site, upgradient well (MW-2) does not indicate such a pattern of migration. In fact, no VOCs were detected in MW-2 or MW-5 (an upgradient, background well).

Semi-Volatile Organic Compounds

The semi-volatile organic compounds were identified in all the media sampled on site. The semi-volatile organic compounds, particularly the PAHs, are persistent in the environment due to their complex chemical nature. Some of the lighter PAHs (fewer aromatic rings) would be subject to biodegradation or volatilization, but the chemical persistence generally increases with

increasing number of aromatic rings. Semi-volatile organic compounds are generally characterized by high boiling point, low vapor pressure, and low solubility (except phenols) (Appendix G).

The semi-volatile organic compounds will be divided into the following groups for discussion: polynuclear aromatic hydrocarbons (PAHs) and naphthalene, phenols, and phthalates.

Polynuclear aromatic hydrocarbons (PAHs) were frequently detected in surface and subsurface soils on site. PAHs generally have a very low solubility (<4.0 mg/l), whereas the solubility of naphthalene is greater (30 mg/l). The K_{OC} of PAHs is generally greater than 2,500 ml/g, with many values greater than 100,000 ml/g. This indicates that PAHs readily adsorb to organic carbon in soils. This accounts for the relative absence of PAHs from ground water samples, with the exception of 2-methylnaphthalene, acenaphthene, anthracene, naphthalene, phenanthrene and pyrene. The highest concentrations of naphthalene were detected in monitoring well MW-4. PAHs and naphthalene were not detected in ground water samples from monitoring wells MW-1, MW-2, or MW-5 (background), which indicates contaminants may not be migrating in ground water at the northern end of the site. There is some indication that contaminant migration may be occurring at this site based on contaminant detection in MW-3 and MW-4.

Phenols and phenol compounds are generally more soluble in water than other semi-volatile organic compounds and display a relatively low volatility (the vapor pressure of phenol is less than the aromatic hydrocarbons but slightly greater than naphthalene; the Henry's Law Constant for phenol is much less than that of naphthalene). Based on the relatively low K_{OC} and high solubility of phenols, they would not tend to adsorb to soils' organic matter; but would tend to leach from soil into ground water. Phenol and phenol

compounds were not detected in surface soil although phenol was detected infrequently (2/36) and at low concentrations in subsurface soil. The apparent absence of phenol compounds from soil may be due to their solubility (leaching potential) or to their biodegradability (Callahan, et al 1979). Phenols were not detected in ground water.

Phthalate compounds were reported in samples from all environmental media collected at the site. It should be noted that phthalates are considered to be common laboratory contaminants and are widespread in the environment (ATSDR, 1987; ATSDR, 1989). The phthalate esters were found in subsurface soil samples at significant rates of detection (>5%).

Phthalate esters generally occur in association with other semi-volatile organic compounds. They generally exhibit low solubility and high K_{OC} , and so would not be particularly amenable to water transport. This is somewhat consistent with the site data which show the phthalates occur at greater concentrations in subsurface soil samples as compared to ground water. The only phthalate detected in ground water was bis(2-ethylhexyl)phthalate, which was detected in MW-3 (associated with oily subsurface soil) and thus may be indicative of migration off site.

Pesticides and PCBs

Pesticides and PCBs were both detected in surface and subsurface soil. In general, pesticides and PCBs have an affinity for organics in soils (e.g., K_{OC} of DDT is 243,000 ml/g), which tends to render them immobile. In addition, many pesticides and PCBs are very persistent.

Pesticides and PCBs at the site appear generally confined to soils. Pesticides (DDT, DDD and DDE) were noted in surface and subsurface soil samples generally at low concentrations and were detected at a frequency

greater than 5%. Gamma-BHC was the only pesticide detected in ground water on site (detected in MW-4). Gamma-BHC was not detected in soils on site, and the relatively low K_{OC} (1080 ml/g) as compared to other pesticides such as DDT ($K_{OC} = 24,300$ ml/g) suggests a greater mobility in soils.

PCBs are generally regarded to be a significant environmental problem because of their persistence and adverse health effects. However, because of the strong tendency of PCBs to adsorb to organic matter in soils, PCBs do not tend to migrate unless solvents or oils are present (Callahan et al, 1979).

The PCB Aroclor-1260 was detected frequently in soil at concentrations up to 8.0 mg/kg (surface soil) and 27 mg/kg (subsurface soil). Aroclor-1254 was also detected frequently in subsurface soil with concentrations ranging up to 1.9 mg/kg. Aroclor-1260 was also detected in ground water at MW-3 (located in area of oily subsurface soil) and MW-4. Pesticide/PCB data indicate that these compounds may be migrating in ground water.

3.3 Exposure Assessment

3.3.1 Development of Exposure Scenarios

The most critical aspect of a technically sound exposure assessment is the identification of exposure routes, together with the identification of human receptors. The Melville North Landfill site is currently not in use. Access to the site is restricted by a gate and some fencing, although the fence does not extend along the length of the site. Signs are posted on the fence to indicate "Private Property, No Trespassing and No Dumping." Based on these findings stemming from site visits and discussions with field personnel, the following potential current human exposure scenarios were identified:

- Persons having access to the site may be potential receptors as trespassers (especially children playing on the site).

Migration of contaminants into Narragansett Bay may result in shellfish contamination. Although fishing is restricted in the area of the Melville North landfill, the potential exists for exposure to contaminated shellfish.

Several potential future exposure pathways exist at the site, including:

- Construction of buildings on the site (i.e., development of the site into a commercial/industrial marina), presenting a potential for exposure of construction workers to site contaminants.
- Commercial/industrial use of the site, presenting a potential for exposure of employees to site contaminants.
- Residential use of the site, presenting a potential for exposure of adults and children to site contaminants, including use of ground water as a potable drinking water source. EPA Region I requires analysis of future residential use of the Melville North Landfill site.

Each scenario includes a particular potential "receptor population", and a consideration of the pathways by which those receptors may encounter contaminants of concern. The values and assumptions used for each exposure scenario were prepared in keeping with generally accepted values in the discipline of risk assessment; the values are not based on a detailed time-activity studies. Specific assumptions and details for each exposure scenario are presented in Appendix B.

3.3.2 Exposure Scenarios Addressed in the Health Assessment

Scenario 1 - Current Use Scenario

Appendix B of this report presents the model inputs for the exposure routes for children trespassing on the site. It is assumed that children trespass onto the site on an infrequent basis, estimated to be approximately one day per year, that children are unlikely to enter the site on a regular basis before the age of 9 due to its distance from residences, and that

exposures are not expected beyond the age of 18 due to changes in the use of recreational time.

Play activities would be expected to result in dermal exposure to and incidental ingestion of surface soil. For dermal exposure, children are assumed to have exposed forearms, hands, feet and lower legs (EPA, 1989a). It is assumed that children older than 6 years will ingest 100 mg of soil per day, with 100% of that occurring on site. With regard to dermal and ingestion absorption factors, this assessment follows guidance provided by Region I (EPA, 1989a). Absorption factors are presented in Appendix B.

Scenario 2 - Construction Scenario - Future Use

In the future, construction workers may be involved in building a commercial/industrial marina on the site. Appendix B presents the model inputs for the exposure routes that construction workers involved in site development could potentially encounter. Excavation and site preparation activities could cause workers to receive inhalation exposure to contaminants in dust, as well as dermal and ingestion exposures to contaminants in soil. It is assumed that workers are engaged in the construction of the marina, with excavation and site preparation activities lasting for a 12-month period. It is also assumed that remediation of contaminants would not occur prior to construction. The inhalation rate is based upon workers undergoing moderate exertion, and dermal exposure is based upon exposed hands and feet (EPA, 1989a). The soil ingestion rate is set at 480 mg/day (EPA, 1991).

Scenario 3 - Commercial/Industrial Scenario - Future Use

Appendix B presents the model inputs for the exposure routes that future employees of a commercial/industrial facility on-site could potentially

encounter. Such exposures are most likely to include incidental ingestion and dermal exposure to contaminants in soil. It is assumed that employees would be on site five days/week, 25 weeks/year for twenty-five years (EPA, 1991).

Scenario 4 - Residential Scenario: Children and Adults - Future Use

A future use residential scenario was constructed to evaluate the possible risks associated with residing on the site as it currently exists.

Appendix B presents the model inputs for the exposure routes that children and adults who live on site might receive. Children, aged 0-6 years, and adults are modeled to receive exposures through soil/house dust ingestion, dermal contact with soil based upon exposed forearms, hands, feet and lower legs (EPA, 1989a), inhalation of contaminants in dust outdoors from wind erosion, inhalation of volatile organic compounds released into bathroom air during showering, and ingestion of contaminants in drinking water. These exposures are assumed to occur on 350 days/year over a 6 year period for children and 30 years for adults. Children are assumed to ingest 750 ml water and 200 mg of soil/house dust per day, while for adults, these values are 2 liters of water/day and 100 mg soil/day.

3.3.3 Estimating Environmental Concentrations

All exposure point concentrations used in assessing receptor dose were calculated as specified in Supplemental Risk Assessment Guidance for the Superfund Program (EPA, 1989a).

The contaminant concentration used in the evaluation of on-site health risk was calculated using the geometric mean method as specified by EPA Region I (EPA, 1989a). Because the majority of the data collected showed a log normal distribution, a geometric mean was calculated rather than an arithmetic

mean for all media on all sites in this risk assessment. The geometric mean value is typically somewhat lower than the arithmetic mean. However, the exposures are calculated based upon the maximum concentration of an agent detected on-site, as well as for the geometric mean concentration. Therefore, the assessment encompasses the mean level of exposure and risk (average case) and also the upper bound (worst case). Calculation of a geometric mean is less conservative than an arithmetic mean, such that the use of a geometric mean and maximum provides lower and upper bounds on exposure point concentrations.

As indicated in the data evaluation section, non-detect values were included in the calculation of exposure point concentrations (i.e., soil concentrations) either as one-half the SQL or as the SQL itself. These non-detected values include detection limits indicated by a "U" qualifier. In general, SQL's were evaluated in light of detection limits and quantifiable ("hits") concentrations of each contaminant. SQLs were independently analyzed and they were incorporated into the quantitative analysis only in those cases in which the compound was detected in the matrix under consideration or in related matrices.

3.3.4 Evaluating Uncertainty

Tables 3-1 through 3-3 summarize contaminant concentrations in soil and ground water, both as a range of detection across the site and as the value used (either the mean or the maximum detected concentration) in the risk assessment. Table 3-4 provides a summary of ranges of detected contaminants across all media.

Table 3-5 summarizes the assumptions used to estimate exposure (i.e., soil ingestion rate, exposure frequency, etc.). The exposure estimates produced

for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion will focus on these parameters, and the associated range of uncertainty. Table 3-5 summarizes the parameters and values used to estimate exposure. The table is separated into those parameters which apply to all scenarios (i.e., global variables), and those which apply specifically to an individual scenario.

- Global Variables

Table 3-5 lists the parameters and associated values which are used in each of the scenarios. Body weight ranges for children (age 9-18 years) were derived from EPA (1990b). The actual value used (49.2 kg) represents an average body weight for this group. Similarly, for children ages 0-6 and adults (18-65 years), a range of body weights is presented, along with the average body weight (14.5 kg and 70 kg, respectively) for the group. While there is a range of body weights for each age group, these ranges are not large, and are not expected to contribute a significant degree of uncertainty to this assessment.

The exposure duration (ED) used for Scenario 1 was based on the assumption that children spend a duration of nine years at the site. This ED is based upon the age range of children likely to trespass onto the site. In theory, this duration might range from 1 to 18 years, however, it is unlikely that children younger than 9 years of age would visit the site. For Scenario 2, construction use, an ED equal to one year was used. In keeping with future use of the site as a marina (Scenario 3), an ED of 25 years was chosen to reflect employee exposure. For Scenario 4, children ages 0-6 were expected to spend the entire six year time frame on site. This ED is the high end of the potential exposure range (1-6 years). Adults were assumed to have an ED equal

to 30 years, which is the national upper-bound (90th percentile) time at one residence. The ED range is 1-70 years, which spans the expected lifetime.

The potential exposure ranges associated with ED are only large when considering adults. However, the ED values used are expected to provide conservative estimates and overstate the potential risk.

Averaging time (AT), which is a pathway specific period of exposure for non-carcinogenic effects, calculated as a product of exposure duration and the number of days/year, is dependent on exposure duration, which was discussed above. AT is not expected to lend a large degree of uncertainty to the exposure estimates.

The ranges of relative absorption factors (RAF) for organic and inorganic compounds vary from no absorption (0) to complete absorption (1). This range is likely to contribute a large degree of uncertainty to the exposure estimates. The values chosen for RAF are taken from EPA (1989a) and are presented in Table 3-5 and Appendix B.

The permeability constant (PC) for each chemical was assumed to be equal to the penetration rate of water, rather than a compound specific value. Thus, the PC may lend a degree of uncertainty in that some compounds will not readily penetrate skin, while others will penetrate at a rapid rate.

The soil contact rate (SCR) established by EPA Region I (EPA, 1989a) is based upon three parameters: soil deposition rate, skin surface area and percent (fraction) exposed. Each of these parameters contains some degree of uncertainty. Soil deposition rate (also known as soil adherence factor) may range up to 2.77 mg/cm^2 for Kaolin clay (EPA, 1989). The value used by EPA Region I of 0.5 mg/cm^2 was chosen as a reasonable estimate following a literature review (EPA, 1989a). Thus, a five fold difference exists between the actual value used and an upper bound estimate of adherence. Region I

— guidance suggests the use of a skin surface area (SA) of 2,000 cm², and is based on the SA of the hands, forearms, feet and lower legs of a young child or the hands and feet of an adult (EPA, 1989a). A large degree of uncertainty is associated with this value, and is dependent on age and area exposed. For example, the 50th percentile total body SA for adult males is 19,400 cm², while the 50th percentile SA for adult male hands is 820 cm² (EPA, 1989). Finally, a factor of 50% is applied to account for the percentage of SA actually covered with soil (EPA, 1989a). This factor is not likely to contribute much uncertainty to the assessment.

The fraction of soil ingested (FI) from the site ranges from 0-1. As a highly conservative estimate, and based on an event-based approach, it was assumed that all soil ingested came from the site.

Finally, concentrations of contaminants in all media were presented as a geometric mean and as a maximum detected concentration. For some chemicals the range of potential concentrations across the site is very large, introducing a high degree of uncertainty to the exposure estimates. However, the exposure estimates are expected to over-predict rather than under-predict, and therefore are protective of human health.

- Scenario 1 - Trespassing Exposure: Current Use

The exposure frequency (EF; days/year) may range from 1 to 365, which may introduce the greatest degree of uncertainty. The value used (1 day per year) was based on the distance of the site from residences and information from field personnel that no trespassing activities had been observed. Soil ingestion rate also presents a large range of values but the value used is not expected to introduce a large degree of uncertainty into the exposure estimate.

- Scenario 2 - Construction Exposure: Future Use

Of the parameters presented in Table 3-5, the modeled ambient dust concentration is expected to present the largest degree of uncertainty to the exposure estimates. Exposure point concentrations available at the site include concentrations in soils and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix B. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results.

- Scenario 3 - Commercial/Industrial Exposure: Future Use

Exposure frequency and soil ingestion rate are not expected to contribute a large degree of uncertainty to the exposure estimates.

- Scenario 4 - Residential Scenario: Future Use

Of the parameters presented in Table 3-5, the modeling of ambient dust concentrations and indoor airborne vapor phase chemical concentrations are expected to present the largest degree of uncertainty. Exposure point concentrations available at the site include concentrations in soil sediments and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for

the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix B. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results.

3.4 Toxicity Assessment

Appendix F of this report presents a short description of the toxic effects of each chemical of concern, including a summary of the dose-response information pertinent to quantitative risk assessment, as available. Furthermore, Tables F-1 through F-4 present a summary of toxicity values associated with chronic and subchronic noncarcinogenic effects, for the oral and inhalation routes, respectively. Tables F-5 and F-6 summarize the slope factors associated with potential carcinogenic effects of chemicals of concern by the oral and inhalation routes, respectively.

3.5 Risk Characterization

3.5.1 Quantitative Risk Assessment

For potential carcinogens, risks are estimated as probabilities. The compound-specific potency factors for carcinogens are generally estimated through the use of mathematical extrapolation models (e.g., the linearized multistage model). These models estimate the largest possible linear slope, within a 95% confidence interval, at low extrapolated doses. Thus, the potency factor is characterized as a 95% upperbound estimate, such that the true risk is not likely to exceed the upperbound estimate and may be lower.

The evaluation of risk from noncarcinogenic health hazards is based on the use of RfDs (EPA, 1990; EPA, 1989a). RfDs are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period. The RfD is calculated by dividing the no adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty factor, which is multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgement regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a LOAEL to a NOAEL, and
- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used.

The results of the quantitative risk analysis are presented in two basic forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given exposure. In numerical terms, these risk estimates are presented in scientific notation in this report. Thus, a lifetime risk of $1\text{E-}04$ means a lifetime incremental risk

of one in ten thousand; a lifetime risk of $1\text{E}-06$ means an incremental lifetime risk of one in one million and so on.

In the cases of exposure to non-carcinogens, the Hazard Index Ratio is used. As noted in previous sections, the fundamental principles used to construct the RfD utilized in calculating the Hazard Index Ratio are predicated on long term or chronic (usually measured in years) exposures and health effects. However, the RfD used was either the RfD derived from chronic studies (RfD_C) or the RfD which was derived from subchronic studies (RfD_S). Wherever possible, the RfD was matched to the type of exposure (chronic vs subchronic) such that in scenarios involving subchronic exposures (e.g., construction), the RfD_S values were used, and in those scenarios involving chronic exposure (trespasser, commercial/industrial use, residential use), the RfD_C values were used.

Cancer and non-cancer health risks are discussed below for trespasser (current use), construction (future use), commercial/industrial (future use) and residential (future use) scenarios. Within the residential scenario, the risks to children (0-6 years old), and adults are presented separately. In each case, daily doses of the compounds of concern have been calculated for each exposure pathway modeled, and these doses were then used to calculate cancer risk levels and hazard index ratios. Cancer risk levels are the lifetime probability of excess cancer due to the exposure pathways resulting from use of the site. Cancer risk levels are derived by multiplying exposure dose by the appropriate cancer slope factor for each compound and exposure route. Non-cancer health risk is quantitated by the hazard index ratio which is the ratio of the exposure dose to the RfD (both in mg/kg/day). The calculated level of cancer risk can be compared to the acceptable total site risk range ($1\text{E}-04$ to $1\text{E}-06$) for evaluating the need for remediation, as

stated in the "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (EPA, 40 CFR Part 300, March 8, 1990), and in the Superfund Human Health Evaluation Manual (1E-04 to 1E-07) (EPA, 1989). Regarding non-carcinogenic health hazards the Superfund Human Health Evaluation Manual (EPA, 1989) states that:

"When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that constitute a concern are $>1E-04$ and $>1E+00$, respectively. Tables 3-6 through 3-13 summarize cancer risk levels and hazard index ratios for each scenario.

Cancer risks and hazard index ratios are presented in subsequent sections for each scenario and pathway analyzed. These risk levels are presented as a range in which both the average case value (geometric mean chemical concentrations) and the worst case value (maximum concentration found on-site) are provided. In certain cases, the geometric mean value may actually be greater than the maximum risk value because "U" data were included in the geometric mean at one-half the SQL, but "U" data were not included in the formulation of maximum values. This is because it is inappropriate for the maximum risk found on-site to be driven by non-detected values. The maximum values do include "UJ" qualified data at the full SQL. Thus, in those cases where a high SQL for a non-detect is greater than any of the detected levels, it is possible for the geometric mean risk to exceed the maximum risk.

Scenario 1 - Trespassing (Current Use): Cancer Risks and Hazard Index Ratios

Tables 3-6 and 3-7 summarize the cancer risks and hazard index ratios for all exposure pathways considered. Appendix B contains the tables which

present these risks on a chemical-by-chemical and pathway basis (Tables B.1-1 through B.1-6).

Exposure of children to contaminants while trespassing on-site is associated with a total cancer risk range of $3.3\text{E-}08$ (average value) to $6.2\text{E-}07$ (maximum value) which is well below the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. The predominant factor contributing to this risk is incidental ingestion of arsenic and carcinogenic PAHs in soil. Dermal exposure to soils is not a significant factor in the risk estimate.

Trespassing on site is associated with a total hazard index ratio range of $2.3\text{E-}04$ (average value) to $1.7\text{E-}03$ (maximum value) which is below the target HI value of $1.0\text{E+}00$. Incidental ingestion of soil is the predominant exposure pathway.

Scenario 2 - Construction Use (Future Use): Cancer Risks and Hazard Index Ratios

Table 3-8 summarizes the cancer risks associated with chemicals and exposure pathways included in this scenario. Appendix B (Tables B.2-1 through B.2-9) presents the exposure dose, cancer risk and hazard index ratio for all compounds and pathways. The total cancer risk range is $2.8\text{E-}06$ (average value) to $3.5\text{E-}05$ (maximum value), which is within the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$). Dermal contact with soil is a minor component of this risk, while incidental ingestion of arsenic and PAH compounds in soil provides the primary contribution. Inhalation of dust-borne contaminants does not appreciably contribute to the cancer risk estimate.

Table 3-9 presents the hazard index ratios for chemicals and exposure pathways. The total HI range is $3.5\text{E-}01$ (average value) to $2.6\text{E+}01$ (maximum value), which spans the level of concern for non-carcinogenic effects (target $\text{HI} = 1\text{E+}00$). Again, incidental ingestion of soil (primarily antimony and

copper) creates most of the HI, while dermal exposure and inhalation of dust exposure pathways makes a considerably lower contribution.

Cancer risk and HI levels are higher for construction workers than for receptors in the trespassing scenario because construction workers are exposed to subsurface soils which appear to be more heavily contaminated than surface soils, particularly for antimony.

Scenario 3 - Commercial/Industrial Use (Future Use): Cancer Risks and Hazard Index Ratios

Tables 3-10 and 3-11 summarize the cancer risks and hazard index ratios associated with future commercial/industrial use of the site. Appendix B (Tables B.3-1 through B.3-9) presents a chemical-by-chemical analysis of each exposure pathway and related dose, cancer risk and hazard index ratio estimates.

Cancer risk estimates range from $1.7\text{E}-04$ (average value) to $2.6\text{E}-04$ (maximum value) for future commercial/industrial use of the site, which exceed the acceptable risk range of $1\text{E}-06$ to $1\text{E}-04$. Ingestion of arsenic, beryllium, 1,1-dichloroethene and trichloroethene in ground water is the predominant route of exposure. It is important to note that while significant risks were identified with the ingestion of 1,1-dichloroethene and trichloroethene, both compounds were identified in ground water only associated with qualified data (Table 3-4). Furthermore, it should be noted that ground water is not used as a potable drinking water source in the area of the Melville North Landfill at this time. Incidental ingestion of contaminants in surface soil provides a minor component of risk ($6.7\text{E}-06$ to $8.1\text{E}-05$) while dermal contact with soil was insignificant.

The hazard index range associated with future commercial/industrial use of the site is $1.6\text{E}+00$ (average value) to $2.5\text{E}+00$ (maximum value). Ingestion of

contaminants in drinking water (e.g., thallium, vanadium and zinc) was the primary contributing factor. A minor component of the total HI is incidental ingestion of soil ($2.0\text{E-}02$ to $1.5\text{E-}01$). Dermal exposure was insignificant.

Scenario 4 - Residential Use (Future Use): Cancer Risks and Hazard Index Ratios

- Children

Table 3-12 presents a summary of the cancer risks for compounds and exposure pathways associated with future residential use of the site. Appendix B (Tables B.4-1 through B.4-16) presents exposure doses, cancer risks and hazard index ratios for Scenario 4. The total cancer risk range for children residing on site is $3.4\text{E-}04$ (average value) to $9.3\text{E-}04$ (maximum value) which is above the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$). The exposure pathways of most importance are: ingestion of arsenic and vinyl chloride in drinking water (associated with a risk of $2.6\text{E-}04$); incidental ingestion of arsenic and PAHs in soil ($5.4\text{E-}05$ to $6.6\text{E-}04$); and inhalation of (vapor phase) VOCs ($1.8\text{E-}05$ to $2.2\text{E-}05$). It is important to note that while significant risks were identified with the ingestion of vinyl chloride, the compound was identified in ground water only in association with qualified data (Table 3-4). Furthermore, it should be noted that ground water is not used as a potable drinking water source in the area of the Melville North Landfill at this time and, based on the proximity of Narragansett Bay, the ground water could be brackish and unsuitable for use as potable water. Inhalation of fugitive dust and dermal exposure pathways do not make significant contributions.

Table 3-13 presents the hazard index ratios for compounds and exposure pathways for Scenario 4. The total HI range for children is $2.8\text{E}+00$ (average value) to $8.8\text{E}+00$ (maximum value), which is above that which may constitute a

concern ($>1E+00$). The most important component of the HI is ingestion of metals in drinking water. This pathway accounts for more than 70% of the total HI. Other pathways of concern are ingestion of chemicals in soil ($3.3E-01$ to $2.5E+00$) and inhalation of vapor phase VOCs ($7E-02$ to $1.2E-01$). Dermal exposure and inhalation of fugitive dusts has little impact on the hazard index ratio.

- Adults

Table 3-12 presents the cancer risks for compounds and each exposure pathway for Scenario 4. The total cancer risk range for adults residing on site is $7.7E-04$ (average value) to $1.0E-03$ (maximum value), which is above the acceptable range ($1E-06$ to $1E-04$). The major contributor to this risk is ingestion of arsenic and vinyl chloride in ground water. Other pathways which contribute to the cancer risk are ingestion of arsenic and PAHs in soil (pathway risk = $2.2E-05$ to $2.7E-04$) and inhalation of vapor phase VOCs ($1.9E-05$ to $2.3E-05$). No elevated cancer risk was caused by the inhalation of fugitive dusts or dermal contact with soil.

Table 3-13 presents the hazard index ratios for compounds and exposure pathways associated with adults residing on-site. The total HI range for all pathways is $1.3E+00$ (average value) to $3.7E+00$ (maximum value), which is greater than the target value of $1E+00$ for HI. Ingestion of inorganics in tap water accounted for the vast majority of the HI. No other exposure routes had elevated HI.

Summary of Cancer and Non-Cancer Health Risks

This site currently contains elevated levels of certain key toxicants, which are responsible for driving the risk assessment. The residential

scenario was associated with the greatest cancer risk and HI levels, due largely to the ingestion of ground water (as tap water) which was absent from Scenarios 1 and 2. Although Scenario 3 addressed ingestion of ground water, the reduced exposure duration and averaging times (as compared to residential exposures) produced a lower risk value. Additionally, the continuous exposure to surface soils (particularly incidental ingestion) in the residential scenario (350 days/year) resulted in risks that are higher in this scenario than in the others. Inhalation of VOCs from tap water was an additional source of excess risk not associated with Scenarios 1, 2 or 3.

Elevated cancer risk estimates were predominantly associated with ingestion of ground water (specifically containing arsenic and vinyl chloride). Several issues should be discussed in light of the uncertainty associated with this pathway. First, as indicated previously, vinyl chloride (a carcinogenic contaminant of concern) was identified in ground water only associated with qualified (UJ) data. Thus, vinyl chloride was not actually detected on-site, and the uncertainty surrounding the sensitivity of the analytical test (the SQL) makes a major contribution to cancer risk from ground water. Second, arsenic levels in ground water on-site did not appear to be elevated when compared to background (upgradient) concentrations. This suggests a non-site-related source of excess risk. Third, based on the proximity of the Melville North Landfill site to Narragansett Bay, the ground water could be brackish and unsuitable for use as potable water. Finally, ground water is not used as a potable source in the area of the site.

Vinyl chloride is a group "A" carcinogen (human carcinogen), whose carcinogenic effects are seen following oral and inhalation exposure. The vinyl chloride oral slope factor is based upon the evidence of induction of lung tumors (ATSDR, 1988). Arsenic is a group "A" carcinogen, whose

carcinogenic effects are most notable in the skin after oral absorption. While the arsenic oral slope factor for carcinogenic effects is based upon the evidence of human skin cancer, arsenic exposure by the oral route has also been associated with elevated cancer incidences in bladder, lung, liver, kidney and colon (EPA, 1991 - IRIS File). The carcinogenic potency of arsenic upon dermal exposure has not been quantitatively evaluated. Arsenic also makes substantial contributions to hazard index ratios due to its potency in causing changes in skin (hyperpigmentation, keratosis) (EPA, 1990 - HEAST).

Exposure to arsenic and PAHs in soil is also of primary importance in each scenario. Seven carcinogenic PAH compounds, including benzo(a)pyrene, were detected on-site and included in the quantitative risk assessment. All were assigned the cancer slope factor derived for benzo(a)pyrene, which is among the most potent members of this chemical class. Most carcinogenic members of this class have been shown to induce skin cancer upon topical administration, while the more heavily studied agent, benzo(a)pyrene, has also been shown to cause lung and stomach tumors (ATSDR, 1990). The cumulative cancer risk associated with this group of chemicals was smaller than arsenic, primarily due to their absence from ground water. Dermal cancer risk was not calculated because of uncertainty regarding the carcinogenic potency of the agents by the dermal route. However, given the preponderance of evidence in rodents that these agents are carcinogenic by dermal exposure, it is likely that this analysis underestimates the cancer risk due to PAH compounds present in soil. However, the increase in cancer risk that could be associated with dermal exposure to PAHs is not likely to be as substantial as oral exposure since the dermal dosage to these agents was generally less than that received via oral exposure.

3.5.2 Qualitative Analysis of Risks

Selected compounds (see Table 3-4) were addressed qualitatively rather than quantitatively because compounds were lacking cancer slope factors or RfD values. It is not possible to include these cases in the quantitative analysis, and instead, the possible effect they could have on the assessment is discussed qualitatively. Few of the compounds missing reference toxicity values (either CPFs or RfDs) were not associated solely with data qualifiers ("U" or "UJ" designations) (Table 3-4). These compounds include:

- Semi-Volatiles
2-methyl naphthalene
- Volatile Organics
benzene
2-butanone
chloroform
- Inorganics
cadmium
cobalt
copper
lead
nickel
thallium
- Pesticides/PCBs
4,4'-DDD
4,4'-DDE
Aroclor - 1260
- Tentatively Identified Compounds

The potential impact associated with the omission of the compounds from the quantitative risk assessment is discussed below.

- Volatile Organics

The chronic oral and inhalation RfDs for benzene have not been established and are pending review by an EPA work group (see Appendix F). Benzene was detected at a range of 0.006 - 0.32 mg/kg in subsurface soil and 3 - 49 ug/l

in ground water. Detection of benzene in surface soil consisted of trace concentrations (0.006 - 0.008 mg/kg) associated with data validators (Table 3-4). Because of the uncertainty associated with the toxicity of benzene, and its detection in subsurface soil and ground water, it is suggested that the absence of this compound may have an impact on the quantitative assessment.

The chronic oral RfD for 2-butanone was estimated from a subchronic inhalation study (see Appendix F). Thus, the oral RfD was used for comparison purposes to estimate the impact of inhalation exposures to 2-butanone. Inhalation exposures (for example, see Appendix B) are not likely to exceed the subchronic oral RfD, such that the lack of a quantitative assessment of inhalation risk due to 2-butanone is not likely to be significant.

A risk assessment to establish a chronic inhalation RfD for chloroform is under review by an EPA work group (see Appendix F). Chloroform was detected at trace concentrations in soil and ground water. Furthermore, data for subsurface soil and ground water is entirely qualified. Based on these considerations, and low resulting exposure doses, the absence of chloroform from the quantitative assessment is not likely to be of concern.

- Inorganics

An inhalation RfD is not available for cadmium (see Appendix F). Inhalation of cadmium has been shown to produce cancers at the route of entry, suggesting an oral to inhalation route extrapolation may not be practical. Based on the uncertainty surrounding the toxicity of inhaled cadmium, it should be noted that the lack of a quantitative assessment may contribute to an underestimate of risk. However, cadmium levels in surface soil were not elevated and there was only one subsurface location where cadmium was elevated (33 mg/kg, B-9). Cadmium has been addressed quantitatively for carcinogenic

effects by the route of inhalation, and exposure doses and risks associated with the inhalation of fugitive dust have not been shown to be significant in this assessment.

Cobalt is an essential component of vitamin B12, which is required for the production of red blood cells. No RfDs were found for cobalt (see Appendix F). Concentrations of cobalt in soil are not unusually high (Tables 3-1 and 3-2). The maximum detected concentration of cobalt in soil was slightly higher than the reported range for U.S. background. Furthermore, cobalt levels in ground water did not exceed the level found in an upgradient well. Due to a lack of a trend of elevated cobalt concentrations, omission from the quantitative assessment is not likely to be of concern.

An inhalation RfD for copper is not available from EPA (see Appendix F). The range of detection of copper in soil appears to be significantly elevated in subsurface soil with concentrations ranging up to 24,400 mg/kg. This suggests some concern for construction workers evaluated in Scenario 2. Because copper has been shown to cause local G.I. irritation following ingestion, it is not practical to extrapolate from the oral route to the inhalation route of exposure. Thus, the contribution of copper to health risks is uncertain. However, it should be noted that doses and risks associated with fugitive dusts are very low.

The EPA weight of evidence for the carcinogenicity of lead is "B2" - a probable human carcinogen; however, a quantitative risk estimate has not been provided (see Appendix F). Lead concentrations in soil appear to be elevated (10.2 - 400.5 mg/kg in surface soil and 1.0 - 6,920 mg/kg in subsurface soil). In general, lead concentrations in ground water appear to be elevated over upgradient concentrations (Table 3-3). Based on the apparently elevated

concentrations of lead in environmental media, some degree of concern over the lack of quantitative cancer risk is noted.

There are no oral or inhalation RfDs for nickel at this time (see Appendix F). The range of detection of nickel in soil is 4.5 - 427 mg/kg (Table 3-4), which is below the reported U.S. background range. An RfD of $1\text{E-}02$ mg/kg/day has been derived in order to calculate a lifetime health advisory for nickel (EPA, 1987a). Comparison of this RfD to oral doses received during current or future use of the site indicates that the omission of nickel from the quantitative risk assessment is not likely to understate risk.

An inhalation RfD is not available for thallium at this time (see Appendix F). The chronic oral RfD is $7\text{E-}05$ mg/kg/day. Thallium concentrations in soil do not appear to be elevated (Tables 3-1 and 3-2), and, in combination with generally low doses and risks associated with inhalation of fugitive dusts, omission from the risk assessment is not likely to be of concern.

- Pesticides/PCBs

No RfDs were found for 4,4'-DDD or 4,4'-DDE. Despite the structural similarity between these agents and 4,4'-DDT, two issues prevent the use of the RfD for DDT. First, toxicological studies suggest that target organ effects may not be similar for DDD and DDE as compared to DDT. Second, pharmacokinetic properties do not appear to be similar. DDD was detected infrequently and at low (trace) concentrations in soil (~ 0.005 mg/kg). DDE levels were somewhat higher (0.002-0.13 mg/kg) but no major impacts in soil were found. Thus, some uncertainty exists due to the omission of DDD and DDE in the quantitative risk analysis, but this uncertainty is not great.

No RfDs were found for Aroclor-1260 (see Appendix F). Little non-carcinogenic effects data is available for PCBs. Although PCBs are addressed quantitatively in the cancer risk assessment, the potential for uncertainty related to non-carcinogenic effects is high, and omission from the risk assessment may be of concern.

- Tentatively Identified Compounds (TICs)

TICs are not quantitatively addressed because their chemical identities were poorly characterized. In the vast majority of samples, the TICs are listed as "unknown hydrocarbons" or simply "unknown". In the few isolated cases where a specific chemical is listed as a TIC, the levels are generally low (<1 mg/kg). Total TIC levels per soil sample range up to 400 mg/kg, but without a better indication of the contaminants which comprise the TIC listing, no qualitative or quantitative assessment can be made.

3.5.3 Uncertainty Assessment

- Site-Specific Uncertainty Factors

The scenarios developed for the site include exposures resulting from probable current use by trespassers and potential future use of the site as a commercial/industrial or residential area. The risks associated with these scenarios are conditional on these land uses occurring. Observations made during field investigations indicate that activities such as trespassing have not occurred on the site, although specific information is not available. Thus, the uncertainty associated with the exposure duration for Scenario 1 may be large, and may contribute significantly to an overestimation of risk. Current zoning for the site is commercial/industrial, although there is some small potential for the site to be used residentially. More likely, the site

will be used as a marina, and evidence suggests that this is the most realistic future case scenario. This uncertainty in future use of the site as a residential area adds a degree of uncertainty to the risks associated with Scenario 4.

Additional uncertainty in the risk characterization may stem from exclusion of chemicals in the quantitative risk assessment. Chemicals which were not included in the quantitative risk assessment were excluded due to either lack of quantitation in the chemical analysis or as a consequence of missing toxicity data.

Any chemicals expected to contribute a significant uncertainty to the assessment of risk were addressed qualitatively. Briefly, the exclusion of compounds with missing RfD values, primarily benzene and Aroclor-1260, may underestimate the cumulative hazard index ratio, while the omission of lead may underestimate the cancer risk estimate.

Chemicals not included in the analysis because they were not detected on-site are not expected to introduce a large degree of uncertainty into the risk estimates. Chemicals not detected on-site were omitted from the analysis on the basis that the sample locations include the most contaminated portions of the site. There is uncertainty with regards to the amount of sampling that would be required to verify that the chemical concentrations used truly represent the geometric mean and maximum values.

Table 3-14 summarizes the exposure pathways considered for the risk assessment, and reasons for exclusion or inclusion. Current ingestion of ground water was not addressed as no wells are currently used as potable water sources.

Two models were used to characterize exposure point concentrations. The first, a model used to estimate concentrations of chemicals in fugitive dust,

was taken from AP-42 (EPA, 1988) (see Appendix B). The key model assumptions include the time frame during which the construction on site is likely to take place and the use of a yearly average wind speed. The potential impact of these assumptions will be to underestimate risk if construction occurs for a longer period of time than originally estimated, or if daily wind speeds exceed the annual average wind speed. The second model, volatilization of chemicals during home use of ground water (i.e., showering) (see Appendix B) was taken from Andelman (1985). A key assumption for this model is likely to include the fraction of contaminant volatilized, which is assumed to be 0.9 (90%). This assumption is likely to overpredict, rather than underpredict, risk.

As indicated previously, the primary routes of exposure for Scenarios 1 and 2 are incidental ingestion of soil, while ingestion of ground water is the primary route of exposure for Scenarios 3 and 4. Site data gaps which resulted in the use of conservative assumptions for Scenario 1 include the frequency with which nearby residents trespass on the site. Similarly, the exposure duration for construction workers (1 year) was based on a conservative assumption, such that the risk estimate may be overestimated. Finally, risks associated with ingestion of ground water rely on the 90th percentile ingestion rate (2 l/day-adults, 0.75 l/day-children), and this may drive the risk estimate for this pathway.

Some significant uncertainties exist in the data used for this site. In all cases these uncertainties are likely to overestimate, rather than underestimate, the risk.

A few examples of data uncertainties include:

- Chemicals detected infrequently in all media were assumed to occur across the site at an average or maximum detected concentration.

"UJ" data (i.e., resulting from matrix effects) were included in calculations of the geometric mean and they were considered as potential locations of contamination. Inclusion of these data in the quantitative assessment introduced a conservative trend in the results.

- "U" data (non-detect values) were included as one-half the SQL, used in calculation of the average, and considered as potential locations of contamination.

- **Uncertainty Surrounding Cancer and Non-Cancer Risks**

For the risk estimation of cancer and of chronic non-cancer health effects, risks from all exposure pathways and for all chemicals have been summated to yield the total site risk for a given receptor. This is a conservative approach, since, in general, different chemicals do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, chemicals may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for chemical transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that certain chemicals can be synergistic such as is the case when a promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator. The uncertainties surrounding these possibilities are discussed below for chemicals found on-site.

Cancer Risks

Elevated PAH levels in surface soil at two locations (SS-1 and SS-6) created high exposures and cancer risks from soil ingestion under worst case (site maximum values used) conditions. However, the risks associated with the geometric mean PAH levels (average case) were approximately 20 fold below that for the worst case, indicating the large differences in exposure and risk that can occur at different locations on-site. This non-uniform distribution of

contamination creates uncertainty in terms of the level of exposure receptors would reasonably receive to PAHs. While it is possible that extensive exposure would occur at the maximum points of contamination, it appears more likely that the geometric mean exposure and risk is more representative. However, 5 of 15 surface soil locations had levels of certain PAHs over 1,000 ug/kg. Since the full geographic extent of these loci of contamination are not known, it is possible that, under certain conditions of site use, risks approaching the worst case level could occur.

Arsenic also made substantial contributions to cancer risk from soil ingestion. However, arsenic levels in on-site surface soils were fairly uniform and they were not unusual for non-impacted soils. The one exception was SS-11 (23 mg/kg). However, even using this one apparently elevated point to represent on-site surface soils, cancer risks for arsenic exposure in soil (worst case) were $\leq 5E-05$. Therefore, this does not appear to be a high level of uncertainty regarding the conclusion that arsenic in on-site soils is not a major risk factor.

Interactions between carcinogens present at this site may both lead to enhanced and diminished carcinogenic responses. Arsenic and PAHs were responsible for elevations in cancer risk on-site. Arsenic is at most only weakly mutagenic, but its carcinogenic effects appear to be mediated through clastogenic effects (ATSDR, 1989). Arsenic-induced chromosomal damage may be due to an impairment of DNA replication or repair, and this effect could facilitate the genotoxic effects of other agents (ATSDR, 1989). Arsenic has been shown to greatly increase the mutagenic effects of direct-acting agents such as UV radiation, and alkylating agents. Further, arsenic appears to increase the production of lung tumors caused by benzo(a)pyrene, and is generally considered to have promotional activity (ATSDR, 1989). The target

organ for arsenic's effects after oral ingestion (inhalation of arsenic is not a major concern at this site) is primarily the skin, but elevations in bladder, liver and lung cancer in humans exposed orally to arsenic have also been reported (EPA, 1991 - IRIS File; ATSDR, 1989). Therefore, it appears that arsenic might be able to enhance the carcinogenic action of other genotoxic agents at a variety of target sites.

Of the carcinogens of concern found on-site, only the group of PAH compounds can be classified as being genotoxic. Like arsenic, the PAH compounds exert genotoxic and carcinogenic effects in skin and at internal organs (ATSDR, 1990). The finding that arsenic can enhance lung tumor production by benzo(a)pyrene (ATSDR, 1989) supports the concept that a synergistic action is possible, particularly since arsenic and PAH compounds are found together in soil. Since the skin is an important target site for both the PAH compounds and arsenic, the synergistic effect might be most probable in the skin. Exposure to the skin may occur both directly by dermal contact, and after ingestion of soil or drinking water.

There is evidence that arsenic's toxic, cytogenetic, and carcinogenic effects can be antagonized by selenium, possibly through an interaction at the level of biliary excretion (ATSDR, 1989).

The carcinogenic PAH compounds are considered to, in general, act similarly with respect to mechanism of action and target organ. However, as a mixture their effects may not be strictly additive due to the potential for co-carcinogenic and antagonistic effects (ATSDR, 1990). These effects appear to be mediated primarily through interference with each other's metabolism - either activation or detoxification, and by inducing, activating or detoxifying enzymes. The difference between antagonism, synergism and additivity of carcinogenic effects appears to depend upon the timing of the

dosage of the different PAHs, the ratio of the different agents administered, and the exact agents involved (Baird, 1984; Slaga, 1979; Van Duren, 1976). These factors are too complex to allow prediction of the likely outcome from the interaction of PAH compounds at this site. However, this factor does introduce uncertainty in the calculation of cancer risks.

Other carcinogens included in the quantitative assessment are beryllium, 1,1-dichloroethene, trichloroethene, vinyl chloride and benzene. All four compounds contributed to cancer risk because of exposure to ground water (bathing, ingestion).

Beryllium is classified as a B2 carcinogen and has been shown to produce skin tumors upon oral exposure. Beryllium was detected in most monitoring wells and so its presence on-site is not in doubt. However, its levels in on-site ground water were not materially different from that in the upgradient reference well. Therefore, the cancer risks related to beryllium ingestion do not appear to be due to conditions specific to this site.

The cancer risks from vinyl chloride, 1,1-dichloroethene, and trichloroethene in ground water may be overestimated in the current assessment since they were identified in ground water only associated with UJ qualified data, and thus they were not positively detected on-site. However, benzene is the sole carcinogenic VOC actually detected in ground water on-site (3 of 5 locations, range = 3-49 ug/l). Therefore, if ground water were used as potable water, then benzene exposures should occur via inhalation (offgassing from bath water) and via ingestion. The oral cancer slope factor for benzene is based upon a dose route extrapolation of the inhalation slope factor derived from human epidemiological studies. Since the primary target organ for benzene carcinogenesis is systemic (hematopoietic system rather than local to the portal of entry), it is possible that switching dose routes will not

greatly affect the carcinogenic potency. However, factors that affect compound delivery to target cells after oral exposure (e.g., first pass effects in the liver) could affect the inhalation vs oral potency comparison, and thus the risk from oral exposure. Since benzene was not a major contributor to cancer risk from ground water, it does not appear that this uncertainty is of primary importance.

The uncertainty surrounding the possibility for ground water use as potable water is an important consideration because a large portion of the cancer risk was associated with this pathway. As noted previously, ground water use at this site is not anticipated due to the likely brackish nature of this water source. Therefore, the most important source of cancer risk on this site may be from surface soil contamination in which PAHs are prevalent.

Non-Cancer Effects

A variety of potential toxicant interactions affecting non-cancer health effects are possible for the chemicals found on-site. The incidental ingestion of soil (containing primarily antimony and copper) is a major contributor to HI at the Melville North Landfill site. While antimony has been responsible for changes in blood glucose and serum cholesterol levels and longevity, copper ingestion causes local gastrointestinal irritation. The ingestion of several chemicals in drinking water (arsenic, mercury, thallium) is also responsible for elevations in the hazard index ratio on-site. Arsenic has been linked to keratosis and hyperpigmentation following oral exposure. Mercury can produce renal degeneration following prolonged oral exposure and neurological disturbances following inhalation of mercury vapors (EPA, 1984). Thallium has been shown to produce alopecia and elevated SGOT and SGPT levels following oral exposure.

Under certain conditions, these agents were individually sufficient to elevate the HI above the threshold of concern (e.g., Scenario 2, worst case - antimony and copper HI values were each greater than 1E+00). However, in other cases (e.g., Scenario 3, worst case; Scenario 4, average and worst case), the HI was elevated not due to any single agent but due to the summation of HI values across several agents. As discussed above, these agents have differing target organs, and thus it may not be appropriate to combine these HI values.

Uncertainties In The Derivation of Toxicity Values

In numerous cases in which a toxicity value was available for one exposure route but not another, a dose route extrapolation was performed. These extrapolations were utilized to go between the oral and inhalation routes of exposure if the toxic/carcinogenic effects were systemic rather than local. The compounds for which this was done are noted in Appendix F. The oral-to-inhalation dose route extrapolation can underestimate potency from inhalation exposure if the chemical is irritating, insoluble, slowly absorbed or highly reactive. Under these conditions, the dose to specific lung regions may be greater than that to the G.I. tract or internal organs, creating the possibility that the lung would be at greater risk. At this site, this possibility is greatest for the oral-to-inhalation extrapolation of RfD values for the metals arsenic, beryllium, nickel and zinc. However, inhalation of these metals was due to the dust inhalation pathway which was a minor exposure route. Therefore, underestimation of toxicity values for inhalation exposure should not have a large effect on the outcome of this risk assessment.

A form of dose route extrapolation was the use of oral toxicity values for dermal exposure. This extrapolation was utilized for all compounds except PAH

compounds, whose potential for dermal effects was discussed. Similar to the case for PAH compounds, the toxicologic effects of arsenic may be greater by the dermal route of exposure. Arsenic produces primarily dermal toxicity and carcinogenesis after oral absorption. Since arsenic is readily excreted, it is likely that the amount of arsenic reaching the skin and accumulating there is considerably lower after oral compared to dermal exposure (ATSDR, 1989). Thus, the effectiveness of a dermal dose of arsenic may be considerably greater than an oral dose. A correction factor was not used for dermal RfDs and slope factors (EPA, Region I) and thus does not take into account the difference between absorbed vs exposure doses in oral vs dermal data. In general, the oral toxicity values are based upon an exposure dose, while the dermal doses for the modeled pathways are in terms of absorbed dose. This lack of an adjustment to the RfDs and slope factors results in a less conservative estimate of risk for some compounds.

Assignment of the benzo(a)pyrene cancer slope factors to other carcinogenic PAH compounds likely creates a considerable overestimate of risk. Benzo(a)pyrene is one of the most potent PAH compounds, and of the others on-site, only dibenzo(a)anthracene has a similar carcinogenic potency (Rugen, 1989; Clement, 1987; EPA, 1985). Chrysene's potency appears to be ~200 fold below that for benzo(a)pyrene. The data upon which these relative potency estimates are based are taken from primarily dermal studies in which the development of skin tumors was studied. The degree of uncertainty in extrapolating these results to the oral route of exposure in order to adjust the oral slope factor is not known. However, these data are applicable to considerations of the cancer risk from dermal exposure. The overestimation created by using the benzo(a)pyrene slope factor as a surrogate for the other PAH compounds partially offsets the possible underestimation of risk from

dermal exposure caused by not adequately characterizing the dermal exposure dose to arsenic and PAH compounds, as described above.

The use of the RfD for naphthalene for all PAHs not currently assigned an RfD is a conservative approach recommended by EPA, Region I (EPA, 1989). Naphthalene's chemical and physical properties are unlike the group of PAHs, suggesting the existence of uncertainty in use of the toxicity values for naphthalene.

4.0 OLD FIRE FIGHTING TRAINING AREA - SITE 09

The Old Fire Fighting Training Area is located on Coasters Harbor Island in Narragansett Bay. The site is bordered by Taylor Drive to the east and Narragansett Bay to the west. Currently, the site is used for multiple purposes including a baseball field, the Teddy Colbert Child Care Center and a picnic/playground recreation area.

4.1 Identification of Chemicals of Potential Concern

4.1.1 Data Collection

Previous geotechnical investigations at the Old Fire Fighting Training Area (conducted by others) had identified subsurface contamination, as characterized by the presence of oily soils. A soil gas survey and geophysical survey were conducted prior to initiation of sampling activities. The soil gas results indicated the presence of volatile organic compounds in the soil gas in an area northwest of the child care center and in the western portion of the site, in the area of a soil mound. Proposed monitoring well locations were adjusted to further investigate these areas.

Six surface soil samples were collected from on-site locations which represented potential areas of concern with respect to human exposure (e.g., child care center, baseball field, park) and from other areas which would provide an indication of the areal extent of surface soil contamination (e.g., soil mounds, shoreline). It is believed that much of the site was covered by fill prior to development of its current site use.

Seven test borings and five well borings were also advanced at various locations throughout the site. One to three samples were generally collected from each boring, depending on the presence of visible contamination and depth

to ground water. Soil borings encountered subsurface building demolition-type debris, oil-stained soils, and hydrocarbon odors.

Four on-site monitoring wells and one off-site, upgradient monitoring well were sampled in July 1990. Strong petroleum odors and a sheen were present in two on-site wells (MW-2 and MW-3), while a light petroleum odor was observed in a third on-site well (MW-4).

4.1.2 Data Evaluation

As detailed in the RI report, the site was used as a fire fighting training facility from World War II to 1972 and exhibits contamination which may be characteristic of materials used in fire training exercises. Field studies have revealed the presence of numerous organic and inorganic contaminants in the surface and subsurface soils and ground water.

In order to organize the data into a form manageable and appropriate for the baseline risk assessment the following steps were followed during the data evaluation process as described by EPA (1989) and EPA (1989a):

- 1) Gather and sort all data by medium (i.e. surface soil, subsurface soil and ground water), and determine the spatial distribution of detects and non-detects;
- 2) Evaluate methods of analysis;
- 3) Evaluate the sample quantitation limits;
- 4) Evaluate the data qualifiers and codes;
- 5) Evaluate blank data;
- 6) Evaluate tentatively identified compounds (TIC's);
- 7) Evaluate background data;
- 8) Develop data sets by medium; and
- 9) Develop a set of chemicals of potential concern from the entire data set.

Briefly, the specific methods used for Site 09 include the following, which correlate with the previously described steps.

- 1) All analytical data was initially sorted by media (surface soil, subsurface soil and ground water). Near shore oil samples were included in the analysis of surface soil data. Surface water sampled (e.g. Narragansett Bay) were not collected in Phase I. Distribution of detects and non-detects was determined such that segregation of contaminated areas could be made when applicable;
- 2) An evaluation of analytical methods was not considered to be necessary as all data used was analyzed by EPA's Superfund Contract Laboratory Program (CLP) procedures;
- 3) Unusually high sample quantitation limits (SQL's) were not commonly reported in any of the matrices analyzed. This indicates that in most cases, matrix or chemical interferences in the analytical determinations did not cause a loss of sensitivity at this site. One-half of the SQL was used for a non-detectable reading if there was evidence that the chemical is present in that medium. However, for non-detects where it appeared more likely that the chemical could be present at a value greater than 1/2 the SQL, the entire SQL was used. The decision to use the full SQL or 1/2 the SQL was based upon extent and degree of contamination within each medium and potential for migration between media. If a chemical was not detected in a single medium, transport and fate information was used to determine if its presence in related media should dictate that it be included in the analysis of this apparently non-impacted medium;
- 4) Data validation qualifiers were assessed during the data evaluation process. As indicated in EPA guidance (EPA, 1989 and 1989a), data qualified with U, J or UJ qualifiers were used in the quantitative risk assessment when appropriate. Chemical data qualified with a "U" (not detected) was used as one half the SQL. Non-detect values were not ignored based on the presence of "hits" within the same media or uncertainty associated with analysis (i.e., "UJ" qualified data);
- 5) Field and laboratory blanks were used to segregate actual site contamination from cross contamination from field or laboratory procedures. As indicated in EPA (1989) sample results were considered positive only if concentrations exceeded ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a chemical that is not considered a common laboratory contaminant;
- 6) Tentatively identified compounds (TICs) were reported in soil samples across the site. TICs ranged from a few unknowns at low concentrations (<100 $\mu\text{g/kg}$) to many TICs each at elevated concentrations (up to 70 mg/kg). Due to the uncertainty associated with the quantitative and qualitative nature of these

TICs, a quantitative assessment of risk associated with exposure was not included in this assessment;

- 7) Background sampling locations were not identified for surface soils at the Old Fire Fighting Training Area. National background levels (i.e., naturally occurring levels) were used as a screening method to evaluate non-site related chemicals or commonly encountered, naturally occurring chemicals. Boring B-5 was considered as an on-site background sampling location for subsurface soil. Thus, comparisons of subsurface soil data to site-related and U.S. background levels was made. Monitoring well MW-5 was located upgradient of the site and was used as a reference for site-related contamination of ground water; and
- 8) Tables 4-1 through 4-3 provide the chemicals and concentrations sampled in surface soils, subsurface soils and ground water, respectively. Table 4-4 provides a summary of chemicals of potential concern in each media.

4.1.3 Summary of Surface Soil Data

Table 4-1 presents a summary of the analytical data associated with chemicals detected in surface soil, organized by class including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class of chemicals is discussed in detail below.

- Inorganics

Of the inorganics analyzed (twenty-four in all), only cyanide was not detected at any of the six locations on site. Inorganics detected infrequently (1/6) include antimony, cadmium, mercury, selenium, silver and thallium. SQL's for inorganics were not unusually high, thus, mean calculations were not adjusted based on the exclusion of "UJ" data. Comparisons to U.S. background (naturally occurring) levels (see Table 4-1) indicate a general trend of elevated concentrations of antimony, arsenic, cadmium, cobalt, copper, lead, mercury, and zinc in surface soil.

Volatile Organics

Only two volatile organic compounds were detected in surface soil. Chloromethane was detected at five out of six locations at trace levels (i.e. at or near the SQL) while tetrachloroethene was detected once at a concentration lower than the SQL. No naturally occurring levels were available for comparison with on-site concentrations of VOCs in surface soils.

- Semi-Volatile Organics

Of the sixty-five semi-volatile organics analyzed for in surface soil and listed in Table 4-1, only one compound (bis(2-chloroethoxy)methane) was not detected at any of the six sampling locations. Polycyclic aromatic hydrocarbons (PAHs) detected at all six sampling locations (6/6) include benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene and pyrene. The concentrations of these PAHs ranged from below the sample quantitation limit (73 µg/kg for fluoranthene at SS-5) to 8,000 µg/kg (for fluoranthene at SS-6). Other PAHs which were detected frequently include benzo(k)fluoranthene (5/6) and benzo(a)pyrene (5/6). All other PAHs were detected at a frequency of 3/6 or less.

With the exception of di-n-butylphthalate (3/6), phthalate esters were not detected in surface soils at a frequency greater than 2/6. Concentrations of phthalate esters range from 500 µg/kg to 520 µg/kg, which is higher than the contract required quantitation limit (CRQL) but within the range of sample quantitation limits (SQL's) for surface soil. Unusually high SQL's occurred occasionally in surface soil samples, particularly in soil sample number 6 (SS-6) which did not have obvious visual contamination. On-site background concentrations for semi-volatile organics in surface soil were not available.

- Pesticides/PCBs

Only the pesticides 4,4'-DDE and 4,4'-DDT were detected on site, each at a frequency of 5/6. The range of detected concentrations was low, with detected concentrations either equal to or below the SQL. Aroclor-1254 was the only PCB detected and was found only once in six samples at a concentration below the SQL.

4.1.4 Summary of Subsurface Soil Data

Table 4-2 presents a summary of the analytical data associated with chemicals detected in subsurface soil, organized by class, including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class is discussed in detail as follows. Depths to twelve feet were used in the risk assessment based on potential site uses.

- Inorganics

Of the inorganics analyzed, only cyanide was not detected at any of the fifteen sampling locations. Most inorganics were detected at a frequency of 13/15 or higher (see Table 4-2). Exceptions include antimony (7/15), cadmium (6/15), mercury (2/15), selenium (9/15) and silver (5/15). Comparisons to background levels (see Table 4-2) indicated elevated concentrations of antimony, cadmium, cobalt, copper, lead, manganese, nickel and zinc in subsurface soil.

- Volatile Organics

Of the volatile organics (VOCs) detected, only four VOCs were detected as frequently as 4/17 locations; all other VOCs were detected less frequently. These frequently detected compounds include 2-hexanone, chloromethane,

ethylbenzene and xylenes. Comparison to background levels indicate a general trend of elevated concentrations of these four VOC's. However, it is important to note that the concentrations of these organics were low, and were within the range of the SQL. Of the remaining VOCs, only 2-butanone concentrations (detected at two locations) appeared to be elevated, exceeding the SQL by 1 to 2 orders of magnitude.

- Semi-Volatile Organics

Of the sixty-five semi-volatile organics listed in Table 4-2 for subsurface soil, two were not detected at any of the seventeen (17) sample locations on-site. Furthermore, one compound was detected only once and thirty-nine compounds were detected only twice. Of these forty infrequently detected compounds, all were detected at low concentrations (i.e., close to or less than the detection limit). Comparisons to background concentrations indicated that these semi-volatile compound concentrations are not elevated. Pyrene, phenanthrene and fluoranthene were the most frequently detected compounds (16/17, 14/17 and 14/17, respectively), with a range of detection from 57 µg/kg to 4,900 µg/kg. Anthracene, benzo(a)anthracene and chrysene were each detected at 11 out of 17 locations. Comparison of these frequently detected PAHs to background concentrations indicated a general trend of elevated PAH concentrations in subsurface samples.

Unusually high SQL's occurred occasionally in subsurface soil samples, particularly in boring sample B-2, with SQLs up to 43,000 µg/kg for phenolic compounds. No visual contamination was noted in this sample.

- Pesticides/PCBs

No pesticides or PCBs were detected in subsurface soil at any location on-site.

4.1.5 Summary of Monitor Well Data

Table 4-3 presents a summary of the analytical data associated with compounds detected in a single round of ground water monitoring. Each class of chemicals is discussed in detail below, with the exception of pesticides/PCBs, which were not detected at any of the five locations.

- Inorganics

Antimony, selenium, silver and vanadium were not detected at any ground water monitoring location. Inorganics detected at a frequency less than 100% include beryllium (1/5), cadmium (1/5), cyanide (1/5), mercury (2/5) and nickel (2/5). Those inorganics whose mean concentrations exceeded on-site background concentrations include arsenic, barium, chromium, copper, lead, mercury, and zinc.

- Volatile Organics

Chloroform was the most frequently detected volatile organic compound (VOC) in ground water (3/5). Acetone and methylene chloride, both common laboratory contaminants, were not detected at any of the five sampling locations. All other VOCs were detected at two locations, although all detections were qualified as "UJ" data. Concentrations of VOCs in ground water are low, that is, near or below the SQL, although the range of detection limits tended to exceed on-site background levels.

- Semi-Volatile Organics

Acenaphthene, dibenzofuran and fluorene were detected most frequently (3/5), although detected concentrations were near or below detection limits. Comparison to on-site background data indicated elevated concentrations of acenaphthene and fluorene. Semi-volatiles not detected included phenolic

compounds (2-methylphenol, 2-nitrophenol, 2,4-dichlorophenol, 2,4-dimethylphenol, 4-chloro-3-methyl-phenol, 4-methylphenol and phenol) and benzoic acid. All other semi-volatile organics were detected one or two times out of five possible locations. In general, data were qualified as "UJ" or "J" and did not contain many clear "hits". Detected or estimated concentrations were low (in general, at or below SQL and background concentrations). Comparison of semi-volatile contamination to background concentrations (MW-5) suggests elevated concentrations of acenaphthene, pentachlorophenol, phenanthrene and pyrene in MW-2.

4.1.6 Selection of Contaminants of Concern

Table 4-4 presents a summary of contaminants in all media sampled (as a range of detection). Chemicals carried through the quantitative risk assessment are marked with a single asterisk (*) to the right of the chemical name. Chemicals discussed in the qualitative risk assessment are marked with two asterisks (**) to the right of the chemical name. Those chemicals addressed both quantitatively and qualitatively are marked with three asterisks (***). Chemicals detected on site and associated completely with data qualifiers ("U" or "UJ" designations) are noted accordingly. Finally, contaminants of concern for this site are labeled in Table 4-4.

Chemicals of potential concern were selected from Tables 4-1 through 4-3 based upon their presence in a matrix and their potential to produce toxic effects. All chemicals positively identified in a matrix are included as chemicals of concern, and the associated risks are quantitated if cancer potency factors and RfD values are available. If these are unavailable, then the chemical's potential to produce adverse health impacts is considered for qualitative assessment.

Chemicals of potential concern are also those with "UJ" qualified data because of the uncertainty surrounding the SQL and thus the sensitivity of the analysis. Much of this uncertainty is removed if "UJ" data are the rare exception rather than the rule for a chemical, and there are no other sampling locations where the chemical was detected in that matrix. Further, if the reported SQL is not unusually high and if there are not a priori reasons to suspect that the "UJ" data are in a contaminated zone (e.g., other "hits" in the matrix, site history, visual/odorous indicators), then it is appropriate to treat the data point as not detected and thus exclude it from the quantitative risk assessment.

Some of the chemicals of potential concern listed in Table 4-4 were selected because of "UJ" data. The number of samples collected in each matrix was not always large, and thus there is low confidence that the one or several "UJ" samples represent clear evidence of chemical absence in that matrix. Chemicals of potential concern solely because of "UJ" data were included in the risk assessment only if they are carcinogens. Thus, the uncertainty surrounding the "UJ" data is handled by inclusion of these data in the quantitative risk assessment for carcinogens. In cases where "UJ" data are included in the quantitative assessment, the SQL (not one-half the SQL) was used because of the probability that the SQL was underestimated in these samples.

4.2 Contaminant Fate and Transport

This section of the risk assessment evaluates the fate and transport of contaminants associated with the site and provides an indication of future contaminant movement. Section 4.1 outlines the occurrence of contamination across the site in surface soil, subsurface soil, and ground water. Observed

contamination consists mainly of: numerous inorganics and polycyclic aromatic hydrocarbons (PAHs) in the surface soils; inorganics and PAHs in subsurface soils; and VOCs, semi-volatiles, and inorganics in the ground water.

4.2.1 Potential Routes of Migration

The contaminant concentration used in the evaluation of on-site health risk was calculated using the geometric mean method as specified by EPA Region I (1989a). Because the majority of the data collected showed a log normal distribution, a geometric mean was calculated rather than an arithmetic mean for all media on all sites in this risk assessment.

To determine the fate of contaminants of potential concern at the site, information on the physical/chemical and environmental fate properties was collected for site contaminants. This information is presented in Appendix G for selected contaminants of concern. Several of the environmental media studied have the potential for off-site migration, primarily surface soils and ground water. Subsurface soils are not likely to be at risk of transport off-site unless exposed by excavation. Although the subsurface soils contain several chemicals of concern, the mode of transport of the chemicals would be primarily through leaching and ground water transport.

Contaminants in surface soils can migrate or be carried from the site by surface runoff (resulting from precipitation), in the form of fine particulates sorbed to windblown dust, and by users of the site via vehicle tires, shoes, etc. In addition, contaminants can move from the surface soils (leaving the soils in place) through leaching by infiltration of precipitation and transport by ground water, and volatilization to ambient air. Finally, transport of contaminants to plants or animals which may potentially be consumed by humans is a possible route of migration.

The sampling results have demonstrated that ground water has been impacted by the site. The ground water investigations indicate that the ground water flows to the north/northwest (toward Narragansett Bay). Ground water is not used as a drinking water source in the vicinity of the site.

4.2.2 Contaminant Distribution and Observed Migration

The following section examines the contaminant presence across the site, (also discussed in Section 4.1), in combination with the migration pathways, to provide an understanding of contaminant persistence and migration at the site. The discussions below are presented with respect to individual contaminants or contaminant groups. Contaminants observed in the environmental samples collected from the site include volatile organic compounds, semi-volatile organic compounds, PCBs, pesticides, and inorganics.

Inorganic Analytes

Many metals have an affinity for soils (particularly clay particles and organic matter in soils) which reduce their mobility. Under extremes of pH, some metals can be rendered mobile. The presence of the inorganic analytes, particularly the naturally occurring elements, must be examined in the context of natural background concentrations, as presented in Table 4-1. The analytes which appeared elevated above US background surface soil levels in one or more samples are: antimony, arsenic, cadmium, cobalt, copper, lead, mercury and zinc. The analytes which appeared elevated above background in subsurface soil samples include antimony, cadmium, cobalt, copper, lead, manganese, nickel, and zinc.

Many inorganics were widespread in on-site ground water samples, suggesting migration has occurred from soils. Comparisons of inorganic

concentrations in ground water on-site to upgradient concentrations indicate that a general trend of elevated concentrations occurs for arsenic, barium, chromium, copper, lead, mercury and zinc (Table 4-3). In order to examine the potential migration of inorganics off-site, data from monitor wells MW-2 and MW-4 were compared to on-site ground water contamination trends. Concentrations of numerous inorganics appeared elevated in MW-2 and/or MW-4, suggesting movement of these analytes in the ground water.

Volatile Organic Compounds

Only two volatile organic compounds (VOCs) were detected in surface soils on-site (chloromethane and tetrachloroethene). Both were detected at very low concentrations (at or below the SQL). Volatile organic compounds were detected infrequently in subsurface soil (generally at a frequency of 1/17 to 4/17) and at low (trace) concentrations (≤ 10 ug/kg). VOCs were detected in monitoring wells, but were present primarily at low concentrations and qualified as non-detected or estimated concentrations at or near the SQL.

The principal mechanism for the natural removal of aromatic VOCs is through volatilization (EPA, 1979). Vapor pressures (@ approximately 20°C) of the VOC's of concern range from 3.8 mm Hg (2-hexanone) to 1011 mm Hg (chloromethane) and Henry's Law Constant range from 1.49×10^{-5} atm-m³/mol (4-methyl-2-pentanone) to 1.1×10^{-2} atm-m /mol (chloromethane) (see Appendix G for physical/chemical and environmental fate properties). The role of biodegradation in the natural attenuation of these compounds is compound specific. Ranges of half lives of VOCs in surface water tend to be short (1-2 weeks) with a few exceptions. Similarly the role of adsorption is compound specific (e.g., acetone has little tendency to be retained by soils); the amount adsorbed is highly related to the amount of organic carbon in the soil

and is represented numerically by the organic carbon/water partition coefficient (K_{OC}). The compounds with higher K_{OC} values (e.g. ethylbenzene) would be preferably partitioned to organic matter in soils and thus would be less likely to be leached from the soils and transported to the ground water. Some aromatic hydrocarbons are highly mobile. Benzene, for example, has a moderate solubility (1750 mg/l), low K_{OC} (83 ml/g) and short half life (1-6 days in surface water). Therefore, benzene, because of its tendency to volatilize and biodegrade, would be mobile but would not be expected to be very persistent in the environment. Conversely, xylenes, with their lower solubilities (198 mg/l) and higher K_{OC} (240 ml/g), would not be as mobile as benzene, but would be more persistent in the environment as they tend to sorb to soil particles.

Many VOCs were present in two of the five ground water samples, although VOCs were generally detected at low concentrations in ground water samples. The chemical/physical and environmental fate data indicate that these hydrocarbons would be expected to migrate downward in soils to ground water. Comparison of VOC presence in MW-2, but not MW-4 (wells which may be indicative of off-site migration) to other site-related wells indicates some movement of VOCs in the ground water towards Narragansett Bay.

Subsurface soils contained many VOCs detected infrequently and at low concentrations. Primarily the subsurface soils were contaminated with 2-hexanone, chloromethane, ethylbenzene and xylenes, each detected at 4/17 locations. These contaminants have low K_{OC} values and are soluble in water. These properties suggest that both compounds are likely to leach downward through soils to the ground water. Based on the mobility and water solubility of these VOCs and historic use of the site, it is not unusual that increasing patterns of detection were found in subsurface soils.

Semi-Volatile Organics

The semi-volatile organics were identified in all the media sampled on site. The semi-volatile compounds, particularly the PAHs, are persistent in the environment due to their complex chemical nature. Some of the lighter PAHs (fewer aromatic rings) would be subject to biodegradation or volatilization, but the chemical persistence generally increases with increasing number of aromatic rings. Semi-volatile organic compounds are generally characterized by high boiling point, low vapor pressure, and low solubility (except phenols).

The semi-volatile organic compounds will be divided into the following groups for discussion: polynuclear aromatic hydrocarbons (PAHs) and naphthalene, phenols, and phthalates.

Polynuclear aromatic hydrocarbons (PAHs) were frequently detected in surface and subsurface soils on site. PAHs generally have a very low solubility (<4.0 mg/l), whereas the solubility of naphthalene is slightly greater (30 mg/l). The K_{oc} values of PAHs are generally greater than 2,500 ml/g, with many greater than 100,000 ml/g. This indicates that PAHs readily adsorb to organic carbon in soils, and would account for a low detection frequency and low concentration of PAHs in ground water samples. PAHs were detected in monitoring well MW-2, which is a downgradient well and this result may indicate off-site contaminant migration in ground water. Conversely, this pattern was not well established in MW-4, an additional well used to indicate contaminant migration.

Phenols and phenol compounds are generally more soluble in water than other semi-volatile organic compounds and display a relatively low volatility (the vapor pressure of phenol is less than the aromatic hydrocarbons but slightly greater than naphthalene; the Henry's Law Constant for phenol is much

less than that of naphthalene). Based on the relatively low K_{OC} and high solubility of phenols, they would not tend to adsorb to soils' organic matter, but would tend to leach from soil into ground water. Phenol and phenol compounds were detected at a frequency of 2/6 locations in surface soil and 2/17 in subsurface soil, with the exception of phenol which was detected at a frequency greater of 5/17 in subsurface soil.

Phenols were detected infrequently and at trace concentrations in ground water. Analytical data for phenols was estimated, and therefore, associated with data qualifiers. Phenols do not appear to be migrating off-site at this time, and concentrations do not appear to exceed upgradient levels.

Phthalate compounds were reported in samples from all environmental media collected at the site. It should be noted that phthalates are considered to be common laboratory contaminants and are widespread in the environment (ATSDR, 1987; ATSDR, 1989). Di-n-butylphthalate was the most frequently detected phthalate ester in surface soil (3/6). All phthalate esters were detected infrequently in subsurface soil, with detection frequencies ranging from 1/17 to 2/17. Concentrations of phthalate esters in surface and subsurface soil are very low, that is, generally less than the SQL.

Phthalate esters generally occur in association with other semi-volatile organic compounds. They generally exhibit low solubility and high K_{OC} , and so would not be particularly amenable to water transport. This is somewhat consistent with the site data which show the phthalates occur at greater concentrations in soil samples as compared to ground water. Note: All data associated with detection of phthalate esters was qualified during data validation.

Pesticides and PCBs

Pesticides and PCBs were both detected in surface soil, while neither were detected in subsurface soil. In general, pesticides and PCBs have an affinity for organics in soils (e.g., K_{OC} of DDT is 243,000 ml/g), which tends to render them immobile. In addition, many pesticides and PCBs are very persistent.

Pesticides and PCBs at the site appear generally confined to soils. Pesticides/PCBs (DDE, DDT and Aroclor-1254) were noted in surface soil samples generally at low concentrations. No pesticides or PCBs were detected in ground water.

PCBs are generally regarded to be a significant environmental problem because of their persistence and adverse health effects. However, because of the strong tendency of PCBs to adsorb to organic matter in soils, PCBs do not tend to migrate unless solvents or oils are present (Callahan et al, 1979).

4.3 Exposure Assessment

4.3.1 Development of Exposure Scenarios

The most critical aspect of a technically sound exposure assessment is the identification of exposure routes, together with the identification of human receptors. The Old Fire Fighting Training Area is currently used for recreational and child daycare purposes. The site contains a ballfield, picnic tables, recreational equipment (i.e., swings, etc.) and the Teddy Colbert Child Care Center. Access to the base on which the Old Fire Fighting Training Area is located is restricted at a centrally located entrance by a guard, such that the site is not open to the public. Based on these findings stemming from site visits and discussions with field investigators, EPA

Region I personnel, and NETC personnel, the following potential current human exposure scenarios were identified:

- Children having access to the site (i.e., Navy personnel dependents) may be potential receptors, including those being cared for at the Teddy Colbert Child Care Center and those visiting the site for recreational purposes.
- Adults having access to the site (i.e., Navy personnel) may be potential receptors, including those using the site for recreational purposes or working at the Child Care Center.
- The ground water on site is not currently used as a potable drinking water source. However, contaminants may be picked up beneath the site and flow towards Narragansett Bay, resulting in shellfish contamination and a potential future exposure through ingestion.

Several potential future exposure pathways exist at the site, including:

- Construction of buildings on the site (i.e., development of a commercial/industrial site), presenting a potential for exposure of construction workers to site contaminants.
- Commercial/industrial use of the site, presenting potential exposure of employees to site contamination.
- Residential use of the site, presenting a potential for exposure of adults and children to site contaminants, including use of ground water as a potable drinking water source. EPA Region I requires analysis of future residential use of the Old Fire Fighting Training Area site.

Each scenario includes a particular potential "receptor population", and a consideration of the pathways by which those receptors may encounter contaminants of concern. The values and assumptions used for each exposure scenario were prepared in keeping with generally accepted values in the discipline of risk assessment; the values are not based on a detailed time-activity studies. Specific assumptions and details for each exposure scenario are presented in Appendix C.

4.3.2 Exposure Scenarios Addressed in the Health Assessment

Scenario 1 - Child Care Center (Current)

Appendix C of this report presents the model inputs for the exposure routes that use of the Teddy Colbert Child Care Center on the site could potentially create. It is assumed that children 1 to 5 years old are cared for at the facility for five years at 250 days/year (parameter values for 0-6 year old children were chosen to represent these receptors).

Exposure to surface soils are expected to occur within a fenced area adjacent to the daycare building. Exposures are expected to include dermal exposure to soil and incidental ingestion of soil. With regard to dermal and ingestion absorption factors, this assessment follows guidance provided by EPA (1989a). Absorption factors are presented in Appendix C.

Scenario 2 - Recreational Use Scenario (Current)

Areas of the site are currently used for recreation by Navy personnel and contain a playground, pavilion and picnic area. These areas are likely to receive heavy weekend use during summer months. As a result, children are expected to receive dermal and ingestion exposure to contaminants in soil. Appendix C presents the model inputs for the exposure routes associated with children playing on-site. It is assumed that children of Navy personnel may use the site as a recreation area up to 33 days per year, which accounts for two days per week in the summer and less frequent visits the remainder of the year. Additionally, on days in which children play on site, it is assumed that all soil ingestion (100 mg) for that day occurs on site. Children are likely to enter the site on a regular basis between the ages of 6-18 years. Regular exposures of this nature are not expected beyond the age of 18 years because of changes in the use of recreational time. Play activities are

expected to involve contact with surface soil. For dermal exposures, children are assumed to have exposed arms, hands and legs, and dermal penetration of contaminants in soil was modeled as presented in Appendix C. Absorption of soil contaminants after ingestion is also presented in Appendix C.

Scenario 3 - Construction Scenario (Future)

Appendix C presents the model inputs for the exposure routes that construction workers involved in site development could potentially encounter. Excavation and site preparation activities could cause workers to receive inhalation exposure to contaminants in dust, as well as dermal and ingestion exposures to contaminants in soil. It is assumed that workers are engaged in the construction of a commercial/industrial site, with excavation and site preparation activities lasting for a one year period. It is also assumed that remediation of contaminants would not occur prior to construction or prior to the occupation of the commercial/industrial site. The inhalation rate is based upon workers undergoing moderate exertion. The soil ingestion rate is set at 480 mg/day (EPA, 1991).

Scenario 4 - Commercial/Industrial Use Scenario (Future)

Future use of the site for commercial/industrial purposes presents a potential exposure of employees to site contamination. Such exposures are most likely to include incidental ingestion and dermal exposure to contaminants in soil and ingestion of contaminants in drinking water. Workers are assumed to spend 250 days/year on-site for 25 years. Appendix C presents detailed exposure models and assumptions for the future commercial/industrial use scenario.

Scenario 5 - Residential Scenario: Children and Adult (Future)

A future use residential scenario was constructed to evaluate the possible risks associated with residing on the site as it currently exists.

Appendix C presents the model inputs for the exposure routes that children and adults who live on site might receive. Children, aged 0-6 years, and adults are modeled to receive exposures through soil/house dust ingestion, dermal contact with soil, inhalation of contaminants in dust outdoors from wind erosion, inhalation of volatile organic compounds released into bathroom air during showering, and ingestion of contaminants in drinking water. These exposures are assumed to occur on 350 days/year for 6 years for children and 30 years for adults. Children are assumed to ingest 750 ml water and 200 mg of soil/house dust per day, while for adults, these values are 2 liters of water/day and 100 mg soil/day.

4.3.3 Estimating Environmental Concentrations

All exposure point concentrations used in assessing receptor dose were calculated as specified in Supplemental Risk Assessment Guidance for the Superfund Program (EPA, 1989a).

The contaminant concentration used in the evaluation of on-site health risk was calculated using the geometric mean method as specified by EPA Region I (EPA, 1989a). Because the majority of the data collected showed a log normal distribution, a geometric mean was calculated rather than an arithmetic mean for all media on all sites in this risk assessment. The geometric mean value is typically somewhat lower than the arithmetic mean. However, the exposures are calculated based upon the maximum concentration of an agent detected on-site, as well as for the geometric mean concentration. Therefore, the assessment encompasses the mean level of exposure and risk (average case)

and also the upper bound (worst case). Calculation of a geometric mean is less conservative than an arithmetic mean, such that the use of a geometric mean and maximum provides lower and upper bounds on exposure point concentrations.

As indicated in the data evaluation section, non-detect values were included in the calculation of exposure point concentrations (i.e., soil concentrations) either as one-half the SQL or as the SQL itself. These non-detected values include detection limits indicated by a "U" qualifier. In general, SQL's were evaluated in light of detection limits and quantifiable ("hits") concentrations of each contaminant. SQLs were independently analyzed and they were incorporated into the quantitative analysis only in those cases in which the compound was detected in the matrix under consideration or in related matrices.

4.3.4 Evaluating Uncertainty

Tables 4-1 through 4-3 summarize contaminant concentrations in soil and ground water both as a range of detection across the site and as the value used (the geometric mean and the maximum detected concentration) in the risk assessment. Table 4-4 provides a summary of ranges of detected contaminants across all media. Table 4-5 summarizes the assumptions used to estimate exposure (i.e., soil ingestion rate, exposure frequency, etc.).

The exposure estimates produced for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion will focus on these parameters, and the associated range of uncertainty. Table 4-5 summarizes the parameters and values used to estimate exposure. The table is separated into those parameters which apply to all scenarios (i.e., global variables), and those which apply specifically to an individual scenario.

- Global Variables

Table 4-5 lists the parameters and associated values which are used in each of the scenarios. Body weight ranges for children (age 0-18 years) were taken from EPA (1991). For each scenario, the actual body weight value used represents the average of the weighted means for age group. For children ages 0-6 and 6-18, the body weight values were calculated to be 14.5 and 43.2 kg, respectively. For adults (18-65 years), a range of body weights is presented, along with the average (70 kg). In each case the ranges are not large and are not expected to contribute a significant degree of uncertainty to this assessment.

The exposure duration (ED) used for Scenario 1 (children) includes a duration of five years, based upon the age range of children at the daycare facility. In theory, this duration could have a broader range, however, the facility has restricted access areas for this 1-5 year old age group. For Scenario 2, children ages 6-18 were expected to play on the site based on the current use of the site as a recreational area. The ED value used is the high end of the proposed range (6-18 years). For Scenario 3, construction workers were assumed to have an ED equal to one year, which is the time frame expected to encompass construction projects. For Scenario 4, commercial/industrial employees were expected to spend 25 years on-site, which is representative of the amount of time expected for employment at one location. For Scenario 5 (residential use), adults were assumed to have an ED equal to 30 years, which is the national upper-bound (90th percentile) time at one residence. The ED range is 1-70 years, which spans the expected lifetime.

The values used for ED are expected to provide conservative estimates and overstate the potential risk.

Averaging time (AT) which is a pathway specific period of exposure for non-carcinogenic effects (calculated as a product of exposure duration and the number of days/year) is dependent on exposure duration, which was discussed above. AT is not expected to lend a large degree of uncertainty to the exposure estimates.

The potential ranges of dermal, ingestion and inhalation relative absorption factors (RAF) for organic and inorganic compounds vary from no absorption (0) to complete absorption (1). Table 4-5 presents the actual RAF used for each route and class of compound. This range is likely to contribute a large degree of uncertainty to the exposure estimates. The values chosen for RAF are representative of classes of compounds.

The permeability constant (PC) for each chemical was assumed to be equal to the penetration rate of water, rather than on a compound specific basis. Thus, PC may lend a degree of uncertainty in that some compounds will not readily penetrate skin, while others will penetrate at a rapid rate.

The soil contact rate (SCR) established by EPA Region I (EPA, 1989a) is based upon three parameters: soil deposition rate, skin surface area and percent (fraction) exposed. Each of these parameters contains some degree of uncertainty. Soil deposition rate (also known as soil adherence factor) may range up to 2.77 mg/cm² for Kaolin clay (EPA, 1989). The value used by EPA Region I of 0.5 mg/cm² was chosen as a reasonable estimate following a literature review (EPA, 1989a). Thus, a five-fold difference exists between the actual value used and an upper bound estimate of adherence. Region I guidance suggests the use of a skin surface area (SA) of 2,000 cm², and is based on the SA of the hands, forearms, feet and lower legs of a young child or the hands and feet of an adult (EPA, 1989a). A large degree of uncertainty is associated with this value, and is dependent on age and area exposed. For

example, the 50th percentile total body SA for adult males is 19,400 cm², while the 50th percentile SA for adult male hands is 820 cm² (EPA, 1989). Finally, a factor of 50% is applied to account for the percentage of SA actually covered with soil (EPA, 1989a). This factor is not likely to contribute much uncertainty to the assessment.

The fraction of soil ingested (FI) from the site ranges from 0-1. As a highly conservative estimate, and based on an event-based approach, it was assumed that all soil ingested came from the site.

Concentrations of contaminants in all media were presented as a mean and as a maximum detected concentration. For some chemicals the range of potential concentrations across the site is very large, introducing a high degree of uncertainty to the exposure estimates. However, the exposure estimates are expected to over predict rather than under predict, and therefore are protective of human health.

- Scenario 1 - Child Care: Current Use

The exposure frequency (EF; days/year) may range from 1 to 365, and is not likely to introduce a large degree of uncertainty. The value used (250 days) was based on the number of work days in a year, based on consistent use of the facility by working parents, thus reflecting the number of days the child is likely to be at daycare. Soil ingestion rate also presents a large range of values but the value used is not expected to introduce a large degree of uncertainty into the exposure estimates.

- Scenario 2 - Recreational Exposure: Current Use

The exposure frequency may range from 1 to 365 days/year, which may introduce a large degree of uncertainty as no data is available to justify the

actual frequency of use. The value used (33 days/year) is based on recreational use of the site two days per week in the summer and more infrequently during the school year. Soil ingestion rate is not expected to introduce a large degree of uncertainty into the exposure estimates.

- Scenario 3 - Construction Exposure: Future Use

Of the parameters presented in Table 4-5, the modeled ambient dust concentration is expected to present the largest degree of uncertainty to the exposure estimates. Exposure point concentrations available at the site include concentrations in soils and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix C. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results. Of the remaining parameters, the ranges of skin surface area are quite large, and may contribute a large degree of uncertainty to the exposure estimates.

- Scenario 4 - Commercial/Industrial Exposure: Future Use

The EF for Scenario 4 is not expected to contribute a large degree of uncertainty to the exposure assessment. Of the possible range of values (1 - 365 days/year), the value chosen (250 days/year) is most likely to be representative of exposure.

- Scenario 5 - Residential Scenario: Future Use

Of the parameters presented in Table 4-5, the modeling of ambient dust concentrations and indoor airborne vapor phase chemical concentrations are expected to present the largest degree of uncertainty. Exposure point concentrations available at the site include concentrations in soils and ground water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) were not sampled during the field program and thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix C. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results.

4.4 Toxicity Assessment

Appendix F of this report presents a short description of the toxic effects of each chemical of concern, including a summary of the dose-response information pertinent to quantitative risk assessment, as available. Furthermore, Tables F-1 through F-4 present a summary of toxicity values associated with chronic and subchronic noncarcinogenic effects, for the oral and inhalation routes, respectively. Tables F-5 and F-6 summarize the slope factors associated with potential carcinogenic effects of chemicals of concern by the oral and inhalation routes, respectively.

4.5 Risk Characterization

4.5.1 Quantitative Risk Assessment

For potential carcinogens, risks are estimated as probabilities. The compound-specific potency factors for carcinogens are generally estimated through the use of mathematical extrapolation models (e.g., the linearized multistage model). These models estimate the largest possible linear slope, within a 95% confidence interval, at low extrapolated doses. Thus, the potency factor is characterized as a 95% upperbound estimate, such that the true risk is not likely to exceed the upperbound estimate and may be lower.

The evaluation of risk from noncarcinogenic health hazards is based on the use of RfDs (EPA, 1990; EPA, 1989a). RfDs are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period. The RfD is calculated by dividing the no adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty factor, which is multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgement regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a LOAEL to a NOAEL, and
- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used.

The results of the quantitative risk analysis are presented in two basic forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime probability of additional cancer risk associated with the given exposure. In numerical terms, these are presented in scientific notation in this report. Thus, a lifetime risk of $1E-04$ means a lifetime incremental risk of one in ten thousand; a lifetime risk of $1E-06$ means an incremental lifetime risk of one in one million and so on.

In the cases of exposure to non-carcinogens, the Hazard Index Ratio is used. As noted in previous sections, the fundamental principles used to construct the RfD utilized in calculating the Hazard Index Ratio are predicated on long term or chronic (usually measured in years) exposures and health effects. However, the RfD used was either the RfD derived from chronic studies (RfD_C) or the RfD which was derived from subchronic studies (RfD_S). Wherever possible, the RfD was matched to the type of exposure (chronic vs subchronic) such that in scenarios involving subchronic exposures (e.g., construction), the RfD_S values were used, and those scenarios involving chronic exposure (trespasser, commercial/industrial use, residential use), the RfD_C values were used.

Cancer and non-cancer health risks are discussed below for current use and future use scenarios. Within the residential scenario, the risks to children (0-6 years old) and adults are presented separately. In each case, daily doses of the compounds of concern were calculated for each exposure pathway modeled, and these doses were then used to calculate cancer risk levels and hazard index ratios. Cancer risk levels are the lifetime probability of

excess cancer due to the exposure pathways resulting from use of the site. Cancer risk levels are derived by multiplying exposure dose by the appropriate cancer slope factor for each compound and exposure route. Non-cancer health risk is quantitated by the hazard index ratio which is the ratio of the exposure dose to the RfD (both in mg/kg/day). The calculated level of cancer risk can be compared to the acceptable total site risk range ($1E-04$ to $1E-06$) for evaluating the need for remediation, as stated in the "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (EPA, 40 CFR Part 300, March 8, 1990), and in the Superfund Human Health Evaluation Manual ($1E-04$ to $1E-07$) (EPA, 1989). Regarding non-carcinogenic health hazards the Superfund Human Health Evaluation Manual (EPA, 1989) states that:

"When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that constitute a concern are $>1E-04$ and $>1E+00$, respectively. Tables 4-6 through 4-15 summarize cancer risk levels and hazard index ratios for each scenario.

Cancer risks and hazard index ratios are presented in subsequent sections for each scenario and pathway analyzed. These risk levels are presented as a range in which both the average case value (geometric mean chemical concentrations) and the worst case values (maximum concentration found on-site) are provided. In certain cases, the geometric mean value may actually be greater than the maximum risk value because "U" data were included in the geometric mean at one-half the SQL, but "U" data were not included in the formulation of maximum values. This is because it is inappropriate for the maximum risk found on-site to be driven by non-detected values. The maximum values do include "UJ" qualified data at the full SQL. Thus, in those

cases where a high SQL for a non-detect is greater than any of the detected levels, it is possible for the geometric mean risk to exceed the maximum risk.

Scenario 1 - Child Care Use (Current Use) - Cancer Risks and Hazard Index Ratios

Tables 4-6 and 4-7 summarize the cancer risks and hazard index ratios for all exposure pathways considered. The tables present a summary of risks to highlight the major factors which drive the risk. Appendix C (Table C.1-1 through C.1-6) contains the exposure doses, cancer risks and hazard index ratios for all chemicals and all pathways of concern.

Exposure of children ages 1-5 years old to contaminants in soil while playing outside of the daycare facility is associated with a total cancer risk range of $2.9\text{E-}05$ (mean value) to $1.3\text{E-}04$ (maximum value) which is slightly above the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. Specifically, this elevated cancer risk is associated primarily with incidental ingestion of carcinogenic PAHs in soil (risk level of $1.2\text{E-}04$). Ingestion of arsenic in soil contributes to a minor degree. Dermal exposure to contaminants in soil did not contribute significantly to the cancer risk estimate.

Playing on site is associated with a total hazard index ratio range of $2\text{E-}01$ (mean value) to $4.3\text{E-}01$ (maximum value) which is below the target HI value of $1\text{E+}00$. As for cancer risk, non-cancer risks are due primarily to incidental ingestion of soil rather than dermal exposure.

Scenario 2 - Recreation (Current Use) - Cancer Risks and Hazard Index Ratios

Tables 4-8 and 4-9 summarize the cancer risks and hazard index ratios for all exposure pathways considered for Scenario 2, current recreational use. Appendix C (Tables C.2-1 through C.2-6) contains the exposure doses, cancer risks and hazard index ratios for all chemicals and all pathways of concern.

Exposure of children to contaminants in soil while using the recreational facilities at the Old Fire Fighting Training Area is associated with a total cancer risk range of $1.5\text{E-}06$ (mean value) to $7.1\text{E-}06$ (maximum value), which is well within the acceptable cancer risk range of $1\text{E-}06$ to $1\text{E-}04$. The primary contributor to this risk is incidental ingestion of contaminants in soil.

Playing on site is associated with a total hazard index ratio range of $4.4\text{E-}03$ (mean value) to $9.8\text{E-}03$ (maximum value), which is well below the target hazard index ratio of $1.0\text{E+}00$.

Scenario 3 - Construction Use (Future Use) - Cancer Risks and Hazard Index Ratios

Table 4-10 summarizes the cancer risks associated with the significant chemicals of concern and all exposure pathways included in this scenario. The total cancer risk estimate range associated with construction activities on site is $2.0\text{E-}06$ (mean value) to $8.2\text{E-}06$ (maximum value), which is within the acceptable risk range of $1\text{E-}06$ to $1\text{E-}04$. The primary contributor to this risk is incidental ingestion of contaminants in subsurface soil.

Table 4-11 presents a summary of the hazard index ratios for selected chemicals and all exposure pathways associated with Scenario 3. The range of hazard index ratios is $8.8\text{E-}02$ (mean value) to $2.7\text{E-}01$ (maximum value), which is below the target ratio of $1.0\text{E+}00$. Exposures via incidental ingestion of contaminants in soil is the primary cause of this risk. Appendix C (Tables C.3-1 through C.3-9) presents a complete matrix of pathways and chemicals.

Scenario 4 - Commercial/Industrial Use (Future Use) - Cancer Risk and Hazard Index Ratios

Tables 4-12 and 4-13 summarize the cancer risks and hazard index ratios for chemicals and exposure pathways for Scenario 4. Appendix C (Tables C.4-1

through C.4-9) provide complete exposure doses, cancer risks and hazard index ratios for all chemicals of concern and exposure pathways.

The cancer risk range estimates associated with future commercial/ industrial use of the site are $1.5\text{E-}03$ (mean value) to $3.1\text{E-}03$ (maximum value), which exceed the target risk range of $1\text{E-}06$ to $1\text{E-}04$. Nearly 100% of this exceedance is due to ingestion exposure to contaminants in ground water. Specifically, the carcinogenic PAHs and arsenic are associated with the elevated risk value. Several issues are important to note at this time. First, ground water is not used as a potable source in the area of the Old Fire Fighting Training Area. Second, there is evidence to suggest that the ground water at this site is brackish, and is influenced by Narragansett Bay tidal action. Finally, some of the data for both arsenic and the PAHs has been qualified by the data validation as "UJ" and thus presents uncertainty as to the actual nature and extent of contamination.

The hazard index ratio range of estimates associated with Scenario 4 is $8.2\text{E-}01$ (mean value) to $3.1\text{E+}00$ (maximum value). Thus, the maximum exposures exceed the target ratio of $1.0\text{E+}00$. As for the cancer risk estimates, the primary contribution to this exceedance results from the use of the ground water as a potable water source. Specifically, ingestion of the inorganics arsenic, cadmium, copper, manganese and zinc account for 76% of the total hazard index. The same considerations stated above for cancer risk apply here, with the exception of the uncertainty associated with the validity of the data.

Scenario 5 - Residential Use (Future Use) - Cancer Risks and Hazard Index Ratios

- Children

Table 4-14 presents a summary of the cancer risks for selected compounds and each exposure pathway associated with future residential use of the site.

Appendix C (Tables C.5-1 through C.5-16) provides a complete assessment of exposure dose, cancer risk and hazard index ratios associated with future residential use of the Old Fire Fighting Training Area. The total range of cancer risk estimates for children residing on site is $2.0\text{E-}03$ (mean value) to $4.0\text{E-}03$ (maximum value), which exceeds the target risk range of $1\text{E-}06$ to $1\text{E-}04$. The majority of the cancer risk results from ingestion of contaminants in ground water. Specifically, ingestion of arsenic and carcinogenic PAHs contribute the majority of this risk. An additional minor component comes from the ingestion of soil and house dust, with a risk range of $4.8\text{E-}05$ to $2.3\text{E-}04$. Dermal contact with contaminants in soil and inhalation of airborne (vapor phase) and dustborne contaminants did not contribute significantly to the risk. As for Scenario 4, several issues are important to note at this time. First, ground water is not used as a potable source in the area of the Old Fire Fighting Training Area. Second, based on the proximity of the site to Narragansett Bay, the ground water could be brackish and unsuitable for use as potable water. Finally, some of the data for both arsenic and the PAHs has been qualified by the data validator as "UJ" and thus presents uncertainty as to the actual nature and extent of contamination.

The hazard index ratio associated with children residing on site ranges from $4.4\text{E+}00$ (mean value) to $1.6\text{E+}01$ (maximum value) (Table 4-15). This range exceeds the target hazard index of $1.0\text{E+}00$, primarily due to ingestion of chemicals in ground water. More than 50% of this risk results from the ingestion of inorganics such as cadmium, copper, manganese and zinc. Ingestion exposure to soil and house dust results in a pathway hazard index of $2.7\text{E-}01$ to $5.9\text{E-}01$, while inhalation of airborne (vapor phase) chemicals has a pathway hazard index of $3.8\text{E-}02$ to $2.1\text{E-}01$.

As indicated previously, ground water is not currently used as a potable water source and evidence suggests a hydraulic connection between the ground water and Narragansett Bay, resulting in a potential for a brackish (non-potable) quality.

- Adults

Table 4-14 presents a summary of the cancer risks for selected compounds and each exposure pathway. The total range of cancer risks for adults residing on site is $5.1\text{E-}03$ (mean value) to $1.0\text{E-}02$ (maximum value), which is above the acceptable range ($1\text{E-}06$ to $1\text{E-}04$). The majority of the cancer risk results from ingestion of contaminants in ground water. Specifically, ingestion of arsenic, beryllium, 1,1-dichloroethene, and carcinogenic PAHs contribute the majority of this risk. An additional minor component comes from the ingestion of soil and house dust, with a risk range of $2.5\text{E-}05$ to $1.2\text{E-}04$. Dermal contact with contaminants in soil and inhalation of airborne (vapor phase) and dustborne contaminants did not contribute significantly to the risk. As for Scenario 4, several issues are important to note at this time. First, ground water is not used as a potable source in the area of the Old Fire Fighting Training Area. Second, there is evidence to suggest that the ground water at this site is brackish, and is influenced by Narragansett Bay tidal action. Finally, some of the data for both arsenic and the PAHs has been qualified by the data validator as "UJ" and thus presents uncertainty as to the actual nature and extent of contamination by these contaminants.

The hazard index ratio associated with adults residing on site ranges from $2.3\text{E+}00$ (mean value) to $8.84\text{E+}00$ (maximum value) (Table 4-15). This range exceeds the target hazard index of $1.0\text{E+}00$, primarily due to ingestion of chemicals in ground water. More than 50% of this risk results from the

ingestion of inorganics such as cadmium, copper, manganese and zinc. Other exposure pathways do not result in a significant contribution to the hazard index.

As indicated previously, ground water is not currently used as a potable water source and evidence suggests a connection between the ground water and Narragansett Bay, resulting in a potential for a brackish quality.

Summary of Cancer and Non-Cancer Health Risks

This site currently contains elevated levels of certain key toxicants, which are responsible for driving the risk assessment.

The residential scenario was associated with the greatest cancer risk and HI values, due largely to the ingestion of ground water (as a potable water source), which is absent from Scenarios 1, 2 and 3. Scenario 4 (future commercial/industrial use) included the use of ground water as a potable drinking water source, however, shorter exposure durations and exposure frequencies reduces the risks associated with this pathway (although not below acceptable values). In general, soil ingestion, inhalation and dermal contact with contaminants were not major exposure pathways.

The contaminants in ground water causing the greatest cancer risk in Scenario 5 are the carcinogenic PAHs (risk range of $5E-03$ to $1E-02$ in adults), arsenic, beryllium and 1,1-dichloroethene. Ingestion of these carcinogenic PAHs in soil is also of some importance in each scenario.

Seven carcinogenic PAH compounds, including benzo(a)pyrene, were detected on-site and included in the quantitative risk assessment. All were assigned the cancer slope factor derived for benzo(a)pyrene, which is among the most potent members of this chemical class. Most carcinogenic members of this class have been shown to induce skin cancer upon topical administration, while

the more heavily studied agent, benzo(a)pyrene, has also been shown to cause lung and stomach tumors (ATSDR, 1990). Dermal cancer risk was not calculated because of uncertainty regarding the carcinogenic potency of the agents by the dermal route. However, given the preponderance of evidence in rodents that these agents are carcinogenic by dermal exposure, it is likely that this analysis underestimates the cancer risk due to PAH compounds present in water and soil. The increase in cancer risk that could be associated with dermal exposure to PAHs in soil is not likely to be substantial compared to oral exposure risks since the dermal dosage to these agents was generally less than that received via oral exposure to PAHs in soil, and this oral exposure was not associated with substantial risk. Further, this dermal dose represents the absorbed dose, which is only 5% of the exposure dose.

Arsenic is a group "A" carcinogen, whose carcinogen effects are most notable in the skin after oral absorption. While the arsenic oral slope factor for carcinogenic effects is based upon the evidence of human skin cancer, arsenic exposure by the oral route has also been associated with elevated cancer incidences in bladder, lung, liver, kidney and colon (EPA, 1991 - IRIS file). The carcinogenic potency of arsenic upon dermal exposure has not been quantitatively evaluated.

Beryllium is a Class B2 (probable human) carcinogen whose effects are primarily noted in the lung. 1,1-Dichloroethene is classified as a possible human carcinogen ("C"). Oral exposure to this compound has been shown to produce a significant increase in adrenal pheochromocytomas.

Although significant risks are associated with the ingestion of ground water, several issues concerning this pathway must be presented. First, as indicated previously in this report, based on the proximity of the site to Narragansett Bay, the ground water could be brackish and unsuitable for use as

a potable water supply. Second, ground water is not used as a potable source in the area of the site. Third, there is an uncertainty associated with the detection of PAHs and the other carcinogenic compounds in ground water. That is, the data for few PAHs were detected in ground water, and were commonly associated with data qualifiers. Finally, PAHs did not appear to be elevated in three of four wells on-site as compared to MW-5, the upgradient reference well for this site. While levels of a variety of PAHs were detected in MW-2, these levels were relatively low.

Similar to the PAHs, arsenic and beryllium in on-site ground water made substantial contributions to risk, but the levels detected on-site do not appear to be materially elevated relative to the levels in reference wells. Beryllium was detected once out of five ground water samples. The beryllium concentration in this sample was not elevated in comparison to reference concentrations for the five NETC sites. Thus, any risk associated with the ingestion of beryllium in ground water is likely to be due to a natural occurrence for the area. 1,1-Dichloroethene was detected in 2 of 5 wells and this data was qualified as U/UJ data only. Therefore, any risk associated with this compound is uncertain and does not appear likely as 1,1-dichloroethene was not clearly detected.

4.5.2 Qualitative Analysis of Risks

Compounds With Missing Toxicity Values

Selected compounds (Table 4-4) were addressed qualitatively rather than quantitatively because compounds were lacking cancer slope factors or RfD values. It is not possible to include these cases in the quantitative analysis, and instead, the possible effect they could have on the assessment is discussed qualitatively.

Few compounds missing reference toxicity values (either CPFs or RfDs) were not associated solely with data qualifiers ("U" or "UJ" designations) (Table 4-4). These compounds include:

- Inorganics
 - Aluminum
 - Cobalt
 - Copper
 - Nickel
 - Selenium
- Volatile Organics
 - Chloroform
- Semi-Volatiles
 - Phenol
- Pesticides/PCBs
 - 4,4'-DDE
- Tentatively Identified Compounds

The potential impact associated with the omission of these compounds from the quantitative risk assessment is discussed below:

- Inorganics

The toxicity data for aluminum has been evaluated by the EPA and found to be inadequate to develop an inhalation or oral RfD (see Appendix F). Aluminum was detected frequently in soil and ground water. Comparisons to site and U.S. background levels (Tables 4-1 through 4-3) indicate that aluminum concentrations are not elevated. Despite the uncertainty surrounding the dose-response relationship for aluminum, low environmental concentrations indicate exposures are not likely to be of concern.

Currently, no oral or inhalation RfDs for cobalt have been published by the EPA. Cobalt is an essential component of vitamin B12, which is required for the production of red blood cells (see Appendix F). With the exception of

MW-3, cobalt does not appear to be elevated in ground water as compared to upgradient levels (MW-5) (Table 4-3). In surface soil, the range of cobalt concentrations is 4.7 - 20 mg/kg, versus a U.S. background range of 0.3 - 70 mg/kg, although the site mean (8 mg/kg) exceeds the U.S. background mean (5.9 mg/kg). Similarly, in subsurface soils the range of detection is within the U.S. background range. Although the mean site concentration exceeds reported U.S. background mean concentrations, the site mean concentration does not exceed the site background level (Table 4-2). Based on this information, a cobalt RfD is not expected to contribute significant uncertainty to the final risk estimate.

An inhalation RfD for copper is not available from EPA (see Appendix F). The range of detection of copper in soils is 6.1 mg/kg - 312 mg/kg, which is within the range of U.S. background (1 - 700 mg/kg). Conversely, the geometric mean concentrations in site soil exceed reported U.S. background mean concentration (Tables 4-1 and 4-2). Because copper has been shown to cause local G.I. irritation following ingestion, it is not practical to extrapolate from the oral route to the inhalation route. Thus, the contribution of copper exposure to health risks following inhalation is uncertain. However, it should be noted that in general, doses and risks associated with inhalation of contaminants in dusts are very low.

The EPA weight of evidence for the carcinogenicity of lead is "B2" - a probable human carcinogen; however, a quantitative risk estimate has not been provided (see Appendix F). Lead concentrations in surface soil appear to be low (range of 19 mg/kg - 77.8 mg/kg) as compared to the U.S. background range (10 mg/kg - 300 mg/kg). In general, lead concentrations in ground water appear elevated over upgradient concentrations (Table 4-3). Based on the

apparently elevated concentrations of lead in environmental media, some degree of concern over the lack of quantitative risk is noted.

There are no oral or inhalation RfDs for nickel at this time (see Appendix F). Nickel was detected twice in ground water at concentrations greater than two times the background (upgradient) concentration (Table 4-3). The range of detection in soil is 5.4 mg/kg to 28.8 mg/kg (Tables 4-1 and 4-2), as compared to a U.S. background of 5-700 mg/kg. Only two subsurface soil nickel concentrations exceeded site background. An RfD of 1E-02 mg/kg/day has been derived in order to calculate a lifetime health advisory for nickel (EPA, 1987a). Comparison of this RfD to oral doses received during current or future use of the site indicate the omission of nickel from the quantitative assessment is not likely to underestimate risk.

Currently, no inhalation RfD for selenium has been published by the EPA (see Appendix F). Concentrations of selenium in surface and subsurface soils are low (below U.S. background level) (Tables 4-1 and 4-2). In combination with the typically low inhalation exposures to fugitive dust (see Appendix C), the lack of a quantitative assessment for the inhalation of particulate borne selenium is not likely to be of concern.

- Volatile Organics

A risk assessment to establish a chronic inhalation RfD for chloroform is under review by an EPA work group (see Appendix F). Chloroform was not detected in surface soil, and data for subsurface soil were associated entirely with data qualifiers. Thus, the uncertainty of the presence of chloroform in soils is high and the absence of chloroform inhalation through fugitive dust formation is not likely to be of importance.

Chloroform was detected in ground water at the Old Fire Fighting Training Area. Because chloroform is a volatile organic, exposures due to inhalation of vapor phase (airborne) chloroform should be considered (Scenario 5). Oral toxicity studies with chloroform indicate systemic effects rather than local, irritant type effects. Comparison of the exposure dose from chloroform inhalation (Table C.5-5) to the oral RfD ($1\text{E-}02$ mg/kg/day) indicates that this route of exposure is not likely to contribute significantly to the non-cancer hazard index.

- Semi-Volatiles

No inhalation RfD for phenol has been published by the EPA due to inadequate health effects data (see Appendix F). Phenol was detected at 2/6 locations in surface soil, however all surface soil data were associated with data qualifiers. Phenol was also detected in subsurface soil at a range of concentrations of 0.045 - 0.49 mg/kg. Based on this information, lack of a quantitative risk assessment would primarily be of concern for Scenario 3 (future construction use). Consideration of the oral RfD ($6\text{E-}01$ mg/kg/day) for inhalation exposure indicates that exposures to phenol in fugitive dusts are not likely to contribute significantly to the risk estimate.

- Pesticides/PCBs

No inhalation or oral RfDs for 4,4'-DDE are available from EPA (see Appendix F). 4,4'-DDE was detected only in surface soil, and at low concentrations (0.0029 mg/kg to 0.0081 mg/kg). Due to uncertainties such as differences between target organ effects and pharmacokinetic behavior of DDT and DDE, the use of the oral RfD for DDT as an RfD for DDE is not a practical

alternative. Thus, it is not possible to quantify the risk associated with DDE in surface soil.

- Tentatively Identified Compounds

TICs are not quantitatively addressed because their chemical identities were poorly characterized. In the vast majority of samples, the TICs are listed as "unknown". In the few isolated cases where a specific chemical is listed as a TIC, the levels are generally low (<1 mg/kg). Total TIC levels range above 70 mg/kg, but without a better indication of the contaminants which comprise the TIC listing, no qualitative or quantitative assessment can be made.

4.5.3 Uncertainty Assessment

- Site-Specific Uncertainty Factors

The scenarios developed for the site include exposures resulting from current use as a child daycare facility and a recreational area and future use of the site as a construction area, commercial/industrial area and residential area. The risks associated with these scenarios are conditional on these land uses occurring. Observations made during field investigations and site visits indicate that current activities include active use of the daycare facility and recreational facilities. Thus, the uncertainty associated with the exposure duration for Scenarios 1 and 2 is likely to be small and is not likely to contribute significantly to an overestimation of risk. Although current use of the site is primarily recreational, there is some potential for the site to be used industrially and residentially. This uncertainty in future use of the site adds a degree of uncertainty to the risks associated with Scenarios 3, 4, and 5.

Chemicals with missing toxicity values are not expected to introduce a large degree of uncertainty into the risk estimates, as described in Section 4.2. Chemicals not detected on-site were omitted from the analysis on the basis that the samples taken include the worst portions of the site. There is uncertainty with regards to the amount of sampling that would be required to verify that the chemical concentrations used presently truly represent the geometric mean and maximum values.

Additional uncertainty in the risk characterization may stem from exclusion of chemicals in the quantitative risk assessment. Chemicals which were not included in the quantitative risk assessment were excluded due to either lack of quantitation in the chemical analysis or as a consequence of missing toxicity data. Chemicals for which a mean or maximum value could not be estimated were evaluated for adverse health effects.

Any chemicals expected to contribute a significant uncertainty to the assessment of risk were addressed above. Briefly, the exclusion of lead in soil and water may contribute to an underestimation of cancer risk. Exclusion of other chemicals from the quantitative analysis is not expected to significantly alter the risk.

Table 4-16 summarizes the exposure pathways considered for the risk assessment, and reasons for exclusion or inclusion. Ingestion of ground water for current use scenarios was not addressed as no wells are currently developed. Ingestion of and dermal contact with on-shore sediments for current and future land use scenarios was addressed as soil ingestion.

Two models were used to characterize exposure point concentrations. The first, a model used to estimate concentrations of chemicals in fugitive dust, was taken from AP-42 (EPA, 1988) (see Appendix C). The key model assumptions include the time frame during which construction on site is likely to take

place, and the use of a yearly average wind speed. The potential impact of these assumptions will be to underestimate risk if construction activities occur for a longer period of time than originally estimated, or, if daily wind speeds exceed the annual average wind speed. The second model, volatilization of chemicals during home use of ground water (i.e., showering) (see Appendix C) was taken from Andelman (1985). A key assumption for this model is likely to include the fraction of contaminant volatilized, which is assumed to be 0.9 (90%). This assumption is likely to over-predict, rather than under-predict, risk.

As indicated in Section 4.5.1, the primary route of exposure for Scenarios 1, 2 and 3 is incidental ingestion of soil, while ingestion of ground water is the primary route of exposure for Scenarios 4 and 5. Finally, risks associated with ingestion of ground water rely on the 90th percentile ingestion rate (2 l/day - adults, 0.75 l/day - children), and this may drive the risk estimate for this pathway.

Some significant uncertainties exist in the data used for this site. In all cases these uncertainties are likely to overestimate, rather than underestimate, the risk.

A few examples of data uncertainties include:

- Chemicals detected infrequently in all media were assumed to occur across the site at a mean or maximum detected concentration.
- "UJ" data (i.e., resulting from matrix effects) were generally included in calculations of mean values and considered as potential locations of contamination. "U" data (non-detect values) were included as one half the SQL, used in calculation of the mean, and considered as potential locations of contamination.
- Inclusion of PAHs in the quantitative assessment increases the level of conservatism rather than presenting an underestimate of risk.
- Uncertainties in background sampling locations, particularly with regard to inorganic compounds, disallowed exclusion of compounds which may occur naturally at the site.

- **Uncertainty Surrounding Cancer and Non-Cancer Risks**

For the risk estimation of cancer and of chronic non-cancer health effects, risks from all exposure pathways and for all chemicals have been summated to yield the total site risk for a given receptor. This is a conservative approach, since, in general, different chemicals do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, chemicals may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for chemical transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that certain chemicals can be synergistic such as is the case when a promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator. The uncertainties surrounding these possibilities are discussed below for the chemicals found on-site.

Cancer Risks

The major contributors to cancer risk on this site are arsenic and the carcinogenic PAHs present in ground water and in surface soil. Aside from the uncertainties surrounding the calculation of exposure doses discussed previously (e.g., that receptors will drink ground water in future use scenarios), the major uncertainties in the cancer risk assessment for these agents are:

- Uncertainties due to data qualifiers which cause chemical concentrations used in the quantitative assessment to be higher than any levels actually detected on-site;
- Uncertainties in attributing risks to on-site contamination sources versus that which is naturally present in ground water and soils (background);
- Uncertainties in the cancer slope factors assigned to these agents;

- Uncertainties regarding the potential for carcinogens to combine to produce antagonistic, additive, or synergistic interactions; and
- Uncertainties regarding the level of exposure of children to PAHs in surface soil in the currently occupied child care center.

The importance of these uncertainties are qualitatively addressed below.

"UJ" data qualifiers caused the inclusion of three carcinogenic PAHs (benzo(k)fluoranthene, indenopyrene, dibenzoanthracene) into the quantitative assessment in spite of their not being clearly detected (without qualification) on-site. Further, UJ and U data caused the geometric mean concentrations of the carcinogenic PAHs detected in ground water (benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and chrysene) to be 2-3 fold greater than the levels actually found. These factors combine to inflate the cancer risk due to PAHs above that which can be firmly supported by the monitoring data. While the uncertainty surrounding UJ and U data is sufficient to cause a concern regarding potential exposures to PAHs, this uncertainty contributes a greater degree of risk than would appear to be warranted. This is because SQL values were not unusually high and because the actual levels of carcinogenic PAHs in ground water were very low (1-4 ug/l).

Unlike PAHs, the cancer risks produced by arsenic in ground water are driven by actually detected concentrations. While the on-site arsenic levels in ground water (2-17 ug/l) appear to be elevated as compared to that found in the reference well (2 ug/l), these arsenic levels are not unusual for background levels at the NETC region as a whole. The reference wells at the other NETC sites analyzed contained arsenic at 22-54 ug/l. Therefore, it appears that a contributor to cancer risk in this scenario is the natural background of arsenic in ground water.

The major source of cancer risk (PAH exposure) is also uncertain because of the use of extrapolated cancer slope factors for most agents in this

group. The benzo(a)pyrene cancer slope factor was assigned to all carcinogenic PAH compounds, which likely creates a considerable overestimate of risk.

Benzo(a)pyrene is one of the most potent PAH compounds, and of the others on-site, only dibenzo(a)anthracene has a similar carcinogenic potency (Rugen, 1989; Clement, 1987; EPA, 1985). Chrysene's potency appears to be ~200 fold below that for benzo(a)pyrene. The data upon which these relative potency estimates are based are taken from primarily dermal studies in which the development of skin tumors was studied. The degree of uncertainty in extrapolating these results to the oral route of exposure in order to adjust the oral slope factor is not known. However, a considerable overestimation of cancer risk from ingestion of PAHs is possible because of this extrapolation approach.

Interactions between carcinogens present at this site may both lead to enhanced and diminished carcinogenic responses.

Of the carcinogens found on-site, the group of PAH compounds are responsible for the greatest elevations in cancer risk on site. PAH compounds can be classified as being genotoxic. The PAH compounds exert genotoxic and carcinogenic effects in skin and at internal organs (ATSDR, 1989). The carcinogenic PAH compounds are considered to, in general, act similarly with respect to mechanism of action and target organ. However, as a mixture their effects may not be strictly additive due to the potential for co-carcinogenic and antagonistic effects (ATSDR, 1990). These effects appear to be mediated primarily through interference with each other's metabolism - either activation or detoxification, and by inducing, activating or detoxifying enzymes. The difference between antagonism, synergism and additivity of carcinogenic effects appears to depend upon the timing of the dosage of the

different PAHs, the ratio of the different agents administered, and the exact agents involved (Baird, 1984; Slaga, 1979; Van Duren, 1976). These factors are too complex to allow prediction of the likely outcome from the interaction of PAH compounds at this site. However, this factor does introduce uncertainty in the calculation of cancer risks.

Arsenic was also shown to be responsible for elevated cancer risks. Arsenic is at most only weakly mutagenic, but its carcinogenic effects appear to be mediated through clastogenic effects (ATSDR, 1989). Arsenic-induced chromosomal damage may be due to an impairment of DNA replication or repair, and this effect could facilitate the genotoxic effects of other agents (ATSDR, 1989). Arsenic has been shown to greatly increase the mutagenic effects of direct-acting agents such as UV radiation, and alkylating agents. Further, arsenic appears to increase the production of lung tumors caused by benzo(a)pyrene, and is generally considered to have promotional activity (ATSDR, 1989). The target organ for arsenic's effects after oral ingestion (inhalation of arsenic is not a major concern at this site) is primarily the skin, but elevations in bladder, liver and lung cancer in humans exposed orally to arsenic have also been reported (EPA, 1991 - IRIS File; ATSDR, 1989). Therefore, it appears that arsenic might be able to enhance the carcinogenic action of other genotoxic agents at a variety of target sites. The finding that arsenic can enhance lung tumor production by benzo(a)pyrene (ATSDR, 1989) supports the concept that a synergistic action is possible, particularly since arsenic and PAH compounds are found together in soil. Since the skin is an important target site for both the PAH compounds and arsenic, the synergistic effect might be most probable in the skin. Exposure to the skin may occur both directly by dermal contact, and after ingestion of soil or drinking water.

There is evidence that arsenic's toxic, cytogenetic, and carcinogenic effects can be antagonized by selenium, possibly through an interaction at the level of biliary excretion (ATSDR, 1989).

A final uncertainty regarding carcinogenic effects involves the level of exposure of young children to PAHs. This site involves a day care center in the current use scenario. The cancer risks for these children are borderline ($1E-04$) in the worst case and are driven by ingestion of PAHs in soil. It is anticipated that the children will be exposed primarily to surface soils represented by SS-2, since this sample was taken within the fenced-in area within which the child care center is located. The PAH levels detected within this zone are considerably lower (up to 480 ug/kg) than that detected at other points on the site. The worst case risk is driven by a point of contamination (SS-6) at which PAH concentrations range up to 8,000 ug/kg. Although children can receive exposures to this location (it is along Narragansett Bay), it is highly unlikely that this location will provide the major source of soil exposure. Therefore, the average case cancer risk ($3E-05$), which relies upon geometric mean concentrations for the entire site, are a better representation of the risk level associated with this scenario.

Non-Cancer Effects

A variety of potential toxicant interactions affecting non-cancer health effects are possible for the chemicals found on-site. In the average case, elevation of the HI to levels greater than $1E+00$ generally did not occur for individual chemicals, but required the summation of the HI across chemicals. The major contributors to the HI are zinc, manganese, copper and cadmium. However, these agents have differing target organs (zinc-red blood cells; manganese-CNS; copper-G.I. tract; cadmium-kidney) which suggests that it may

be inappropriate to sum the HI values across these different chemical exposures and organ effects. However, in the average case for manganese, and in the worst case for the residential scenario, individual agents were capable to elevate HI to levels greater than $1E+00$.

Therefore, considerations of whether it is appropriate to summate HIs stemming from non-cancer effects that occur in different tissues for different chemicals do not increase the uncertainty in this analysis.

Uncertainties In The Derivation of Toxicity Values

In numerous cases in which a toxicity value was available for one exposure route but not another, a dose route extrapolation was performed. These extrapolations were utilized to go between the oral and inhalation routes of exposure if the toxic/carcinogenic effects were systemic rather than local. The compounds for which this was done are noted in Appendix F. The oral-to-inhalation dose route extrapolation can underestimate potency from inhalation exposure if the chemical is irritating, insoluble, slowly absorbed or highly reactive. Under these conditions, the dose to specific lung regions may be greater than that to the G.I. tract or internal organs, creating the possibility that the lung would be at greater risk. At this site, this possibility is greatest for the oral-to-inhalation extrapolation of RfD values for the metals arsenic, beryllium, nickel and zinc. However, inhalation of these metals was due to the dust inhalation pathway, which was a minor exposure route. Therefore, underestimation of toxicity values for inhalation exposure should not have a large effect on the outcome of this risk assessment.

A form of dose route extrapolation was used to provide oral toxicity values for dermal exposure. This extrapolation was utilized for all compounds except PAH compounds, whose potential for dermal effects was discussed.

A correction factor was not used for dermal RfDs and slope factors to take into account the difference between absorbed vs exposure doses in oral vs dermal data, based on guidance from EPA Region I. In general, the oral toxicity values are based upon an exposure dose, while the dermal doses for the modeled pathways are in terms of an absorbed dose. The absence of the use of such a correction factor provides a less conservative approach in estimating risk.

The use of the RfD for naphthalene for all PAHs not currently assigned an RfD is a conservative approach recommended by EPA, Region I (EPA, 1989). Naphthalene's chemical and physical properties are unlike the group of PAHs, suggesting the existence of uncertainty in the use of the toxicity values for naphthalene.

5.0 TANK FARM FOUR - SITE 12

The Tank Farm Four site is situated at the northern end of the NETC facility in the town of Portsmouth. It is located just east of Narragansett Bay, with Defense Highway bordering the western edge of the site. Twelve large underground storage tanks and an oil/water separator are located on the site, which encompasses approximately 80 acres. The site is no longer used for fuel storage, and the tanks have been emptied and filled with water for ballast.

5.1 Identification of Chemicals of Potential Concern at Tank Farm 4

5.1.1 Data Collection

A soil gas survey was conducted prior to initiation of sampling activities. The results indicated the presence of volatile organic compounds in the soil gas throughout the tank farm site in general, with no clear evidence of a contaminant source or plume.

Twenty-eight surface soil samples were collected from on-site locations. Two soil samples (one composite and one discrete) were collected from around each tank and four were collected from around the oil/water separator. The discrete surface soil sample locations were selected to represent any visibly contaminated areas, where possible.

Eight well borings were advanced at five locations throughout the site. One soil sample was collected at or near the water table from each well location. Eight monitoring wells were installed in the borings, including five overburden wells and three bedrock wells. Each of the bedrock wells was paired with an overburden well. Ground water samples were collected from each of these wells and from two pre-existing on-site wells. One monitoring well situated at the upgradient boundary of the site is considered to be

representative of background for the area surrounding the site. No odors or visible evidence of contamination were observed during well sampling.

Four surface water samples were collected from Norman's Brook, which crosses the southern portion of the site (two on-site, one upstream of the site and one downstream of the site). Two sediment samples were also collected from each of the surface water sample locations. In addition, sediment samples were collected from two additional on-site brook locations.

Underground storage tank contents and on-site structures were also investigated. Twelve oil and eleven water samples were collected from on-site underground storage tanks. Eleven of the twelve tanks contain thick, black bunker-type oil while the remaining tank contains a black, light oil (similar to diesel fuel). One soil sample, one sludge, and one water sample were collected from the oil/water separator. A soil/sediment sample was also collected from a demolished structure (referred to as ruins), with a water sample collected from a pipe which appeared to be discharging water from the ruins structure.

5.1.2 Data Evaluation

As detailed in the RI report, the site may contain tank residues resulting from oil storage operations. Field studies tested for the presence of numerous organic and inorganic contaminants in the soils, sediments, surface water and ground water.

In order to organize the data into a form manageable and appropriate for the baseline risk assessment the following nine steps were followed during the data evaluation process as described by EPA (1989):

- 1) Gather and sort all data by medium (i.e. soil, ground water, etc.);

- 2) Evaluate methods of analysis;
- 3) Evaluate the sample quantitation limits;
- 4) Evaluate the data qualifiers and codes;
- 5) Evaluate blank data;
- 6) Evaluate tentatively identified compounds (TIC's);
- 7) Evaluate background data;
- 8) Develop data sets by medium; and
- 9) Develop a set of chemicals of potential concern from the entire data set.

Briefly, the specific methods used in this report include the following, which correlate respectively with the previously described steps (1-9).

- 1) All analytical data was initially sorted by media (surface soil, subsurface soil, surface water, ground water and sediments);
- 2) An evaluation of analytical methods was not considered to be necessary as all data used was analyzed by EPA's Superfund Contract Laboratory Program (CLP) procedures;
- 3) Unusually high sample quantitation limits (SQL's) were not commonly reported in any of the matrices analyzed. This indicates that in most cases, matrix or chemical interferences in the analytical determinations did not cause a loss of sensitivity at this site. One-half of the SQL was used for a non-detectable reading if there was evidence that the chemical is present in that medium. However, for non-detects where it appeared more likely that the chemical could be present at a value greater than 1/2 the SQL, the entire SQL was used. The decision to use the full SQL or 1/2 the SQL was based upon extent and degree of contamination within each medium and potential for migration between media. If a chemical was not detected in a single medium, transport and fate information was used to determine if its presence in related media should dictate that it be included in the analysis of this apparently non-impacted medium;
- 4) Data validation qualifiers were assessed during the data evaluation process. As indicated in EPA guidance (EPA, 1989), data qualified with U, J or UJ qualifiers were used in the quantitative risk assessment when appropriate. Chemicals that received the U qualifier (not detected) for all samples in a medium were not of concern for that medium. However, chemicals receiving the UJ qualifier, even if just once in a medium, were retained as potential chemicals of concern. At Tank Farm 4 it

was common for all the data from a given medium to be reported as "U" data by the laboratory, but with one of the samples later qualified as "UJ". Since a UJ qualifier represents uncertainty in the SQL, the lack of chemical detection is only equivocal. Faced with this uncertainty, the UJ qualified data is used in the risk assessment (EPA, 1989). However, for practical reasons the scope of the risk assessment was narrowed so that compounds with UJ data were included only if they were deemed to be of sufficient concern based upon toxicity assessment (i.e., if they are considered to be carcinogenic);

- 5) Field and laboratory blanks were used to segregate actual site contamination from cross contamination from field or laboratory procedures. As indicated in EPA (1989) sample results were considered positive only if concentrations exceeded ten times the concentration of a common laboratory contaminant in a blank, or five times the concentration of a chemical that is not considered a common laboratory contaminant;
- 6) Tentatively identified compounds (TICs) were reported in soil samples across the site. TICs ranged from a few unknowns at low concentrations (<1 mg/kg) to many TICs (>10) with some at elevated concentrations (>10 mg/kg). Surface water and ground water samples were generally devoid of TICs. Due to the uncertainty associated with the quantitative and qualitative nature of these TICs, a quantitative assessment of risk associated with exposure was not included in this assessment;
- 7) Background sampling locations were not identified or analyzed at this site. Therefore, only national background levels, where available, could be used as a screening method to evaluate non-site related chemicals or commonly encountered naturally occurring chemicals; and
- 8) Tables 5-1 through 5-5 provide the chemicals sampled and concentrations found in surface soils, subsurface soils, surface water, and ground water, respectively. Sediments were not addressed in the risk assessment as soil exposure is expected to characterize an equivalent or greater risk. Oil/water tank samples were not addressed in the risk assessment as the tank contents cannot be accessed by site visitors. All chemicals analyzed for in each matrix, both those detected and not detected, are presented together with SQLs. Table 5-6 summarizes the analytical chemistry data across all matrices on-site, and this table also provides an overall summary of chemicals of potential concern in each medium. This list was formulated based on guidance provided in Chapter 5 of the Risk Assessment Guidance for Superfund (EPA, 1989).

5.1.3 Summary of Surface Soil Data

Table 5-1 presents a summary of the analytical data associated with chemicals detected in surface soil, organized by class including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Each class of chemicals is discussed in detail below.

- Inorganics

Of 24 inorganic compounds analyzed, only cadmium, selenium, cyanide, silver, sodium and antimony were not detected in surface soil. However, the metals found are not unusual elements in soil and the concentrations present were similar to U.S. background levels.

- Volatile Organics

Of the thirty-four volatile organics analyzed for surface soil, only 2, toluene and tetrachloroethene were detected in the 5 samples collected. For both agents, detection was in 1 of 5 samples and the detected level was at or below the SQL. However, the UJ data qualifier was applied for 21 chemicals, primarily for one sample (SS-1). The uncertainty in the SQL associated with the UJ qualifier together with the rather small data set (5 samples), dictates that the UJ data be viewed as potential concentrations and these 21 chemicals be included as potential chemicals of concern. One sample had consistently high SQLs (SS-3) because of a 100 fold dilution of the sample during the analysis. For two chemicals (4-methyl-2-pentanone, 2-hexanone), the UJ qualifier was associated with these high SQLs. Use of these high SQLs directly (in the cases of UJ data) or using one-half the SQL (in the cases of U data and where the chemical was detected or had the UJ qualifier in another

sample) causes the geometric mean and maximum concentrations for 23 VOCs to be considerably higher than that which would otherwise be the case.

- Semi-Volatile Organics

Twelve of the 65 semi-volatile organic compounds analyzed in surface soil were actually detected on site. Of these twelve, the most commonly detected were phenanthrene (4 of 5 samples), fluoranthene (3 of 5), chrysene (4 of 5), benzo(a)anthracene (3 of 5), and benzo(a)pyrene (3 of 5). In one sample (SS-2), the levels of several of these polycyclic aromatic hydrocarbons (PAHs) exceeded the SQLs by an order of magnitude, which represents a large concentration (6,000-10,000 µg/kg) for this site. Sample SS-2 had high SQLs for the agents not detected because of a 100 fold dilution of the sample during analysis. These high SQLs are used at one-half their level in calculations of the geometric mean and maximum concentrations in surface soil for 55 semi-volatiles. These 55 agents were either actually detected in other samples (9 chemicals) or had surface soil data with the UJ qualifier (46 chemicals).

For most chemicals, the geometric mean data are well above the actual detected concentrations because of the one high SQL set of data. The exceptions to this are the PAHs phenanthrene, pyrene, and chrysene, and the phthalate ester bis(2-ethylhexyl)phthalate, which were found at elevated concentrations in sample SS-2. Only 5 semi-volatiles could be eliminated from consideration in the risk assessment because they clearly were not detected in any of the surface soil samples (i.e., none of the U data were qualified).

- Pesticides/PCBs

PCBs were not detected in any surface soil samples. The only pesticide detected was 4,4'-DDE, a close structural analogue and breakdown product of

DDT. DDE was detected at only one location and this was at a low concentration (4-5 µg/kg). Seven other pesticides (2,4-D, 2,4,5-T, silvex, endrin, gamma-BHC, methoxychlor and toxaphene) received the UJ qualifier at one or two locations, and are thus included as potential chemicals of concern. However, SQL levels were not unusually high for pesticides or PCBs.

- Additional Surface Soil Screens for Lead and TPH

Twenty-eight surface soil samples were obtained and analyzed for TPH while 26 additional samples were analyzed for lead (Table 5-1). This broad screen failed to detect any points of substantial contamination as the highest lead concentration found was 68 mg/kg and the highest TPH concentration was 270 mg/kg.

5.1.4 Summary of Subsurface Soil Data

Table 5-2 presents a summary of the analytical data associated with chemicals detected in subsurface soil, organized by class including semi-volatile organics, volatile organics, inorganics and pesticides/PCBs. Subsurface soil data is derived from a total of 5 well borings. Each class of chemical is discussed in detail as follows. Depths to twelve feet were used in the risk assessment based on potential site uses.

- Inorganics

Of the inorganics analyzed, only cadmium, cyanide, mercury, and sodium were not detected at any of the five sampling locations. Most inorganics were detected at a frequency of 100% (see Table 5-2). SQLs for inorganics were not unusually high, and the detected levels were generally much higher than the SQL. Comparisons to U.S. background levels (see Table 5-2) indicated a

general trend of elevated concentrations across the site for antimony, arsenic, cobalt, and nickel, but in each of these cases the range found on site was within the background U.S. range. The mean level of arsenic in subsurface soil was approximately twice that found in surface soil.

- Volatile Organics

Of the 34 volatile organics (VOCs) analyzed, only tetrachloroethene and toluene were detected. In both cases, levels were very low (1-2 µg/kg) and were well below the SQL. Therefore, based upon the sampling points analyzed, the subsurface soil was not strongly impacted by VOCs.

- Semi-Volatile Organics

None of the 65 semi-volatile organics listed in Table 5-2 for subsurface soil were detected at any of the 5 sampling locations. However, the UJ qualifier was given to the results from one sample (MO4-1). Due to the uncertainty surrounding the analytical test of the assayed chemicals at this location, the SQL was used to represent their concentration. The entire list of semi-volatiles with UJ data was reduced to twenty-eight retained as chemicals of concern for subsurface soil. If UJ data was the reason for not removing an agent from consideration, it was retained as a chemical of concern only if it is a carcinogen. Overall, the data indicate that the subsurface soil points assayed at Tank Farm 4 are not heavily impacted by semi-volatile compounds as a class, or by any individual compounds.

- Pesticides/PCBs

No PCBs were detected in subsurface soil at any location on site. The pesticides DDT, aldrin, dieldrin, endrin and heptachlor were detected in one

location (M05-1), but at very low levels (3-17 µg/kg) which were below the SQL. There was no indication of unusually high SQLs in the analytical data.

5.1.5 Summary of Surface Water Data

Table 5-3 presents a summary of the analytical data for compounds detected in surface water. The following sections describe the data for each class of compound. Surface water sample SW-6 represents an on-site background or reference sampling location.

- Inorganics

A variety of metals were detected in surface water, with several (barium, calcium, iron, magnesium, manganese, potassium, sodium and thallium) detected in each surface water sample. Additionally, arsenic was detected in two samples, and cadmium, chromium, lead and selenium were each detected once. These metals are anticipated in natural waters and for most, the levels found were similar to that at the background location (SW-6). However, levels of zinc at SW-1, and of manganese at SW-1, SW-2 and SW-4, were markedly above the on-site background levels.

- Semi-Volatile Organics, Volatile Organics, Pesticides and PCBs

No pesticides or PCBs were detected in surface water on-site. Additionally, only one semi-volatile compound, bis(2-ethylhexyl) phthalate was detected. This compound was found in two of the four sampling locations, but at very low levels (1 µg/l), which were below the SQL. Of the VOCs, carbon disulfide and carbon tetrachloride were the only chemicals detected, both only at one location. The value for carbon disulfide (26 µg/l) was five times the SQL, while the carbon tetrachloride concentration was 3 µg/l, which was well

below the SQL. Therefore, no major impact on surface water by organic contaminants was present at the monitoring locations.

5.1.6 Summary of Ground Water Data

Table 5-4 presents a summary of the analytical data associated with compounds detected in the ten ground water samples collected. Each class of chemicals is discussed in detail below, with the exception of pesticides/PCBs and volatile organics, which were not detected in ground water on-site and did not have unusually high SQLs. One monitoring well location (MW-5) is upgradient of all underground tanks, and was thus selected for the purposes of serving as an indicator of background concentrations.

- Inorganics

Of the 24 inorganic compounds analyzed, only antimony, cyanide and mercury were not detected in any of the ground water samples. Most of the remaining agents were detected in all 10 samples and at levels well above the SQL. Thus, metals such as arsenic, chromium, cadmium, lead, manganese and nickel were prevalent in ground water; the significance of their levels in ground water is discussed in the risk characterization section of the assessment. In comparison to the reference (background) monitoring well, the level of arsenic at selected locations appears to be considerably above background. For example, at MW-2, MW-3, and MW-6 the shallow depth arsenic concentrations are 448, 284, and 260 ug/l, respectively. In contrast, the reference well (MW-5) had a shallow depth value of 25 µg/l. A similar profile was seen for vanadium, but not for other inorganic compounds.

Two other metals, selenium and thallium, were not positively identified in ground water, but received the "UJ" data qualifier in all 10 ground water samples and thus they are considered as potential chemicals of concern.

- Semi-Volatile Organics

No semi-volatile organic compounds were detected in ground water. However, 3,3-dichlorobenzidine and hexachlorocyclopentadiene both received the "UJ" data qualifier at two locations. Thus, they are retained as potential chemicals of interest in the risk assessment. However, based upon the 10 sampled locations, the data for semi-volatile organic compounds, as well as for PCBs/pesticides and volatile organics indicate that there is not a major organic impact on ground water at this site.

5.1.7 Selection of Chemicals of Concern

Table 5-5 presents an overall summary of the analytical data across all monitored matrices. Chemicals carried through the quantitative risk assessment are marked with a single asterisk (*) to the right of the chemical name. Chemicals discussed in the qualitative risk assessment are marked with two asterisks (**) to the right of the chemical name. Those chemicals addressed both quantitatively and qualitatively are marked with 3 asterisks (***). Additionally, Table 5-5 shows the range of levels detected in the different media and the presence of "UJ" data (indicated by X) so that it is easy to determine whether chemicals of concern are due to UJ data or due to actual occurrence in particular matrices.

Chemicals of potential concern were selected from Tables 5-1 through 5-4 based upon their presence in a matrix and their potential to produce toxic effects. All chemicals positively identified in a matrix are included as chemicals of concern, and the associated risks are quantitated if cancer potency factors and RfD values are available. If these are unavailable, then the chemical's potential to produce adverse health impacts is considered for a qualitative assessment.

Chemicals of potential concern are also those with "UJ" qualified data because of the uncertainty surrounding the SQL and thus the sensitivity of the analysis. Much of this uncertainty is removed if "UJ" data are the rare exception rather than the rule for this chemical, and there are no other sampling locations where the chemical was detected in that matrix. Further, if the reported SQL is not unusually high and if there are not a priori reasons to suspect that the "UJ" data are in a contaminated zone (e.g., other "hits" in the matrix, site history, visual/odorous indicators), then it is appropriate to treat the data point as not detected and thus exclude it from the quantitative risk assessment.

Some of the chemicals of potential concern listed in Table 5-5 were selected because of "UJ" data. The number of samples collected in each matrix (4-10) was not large, and thus there is low confidence that the one or several "UJ" samples represent clear evidence of chemical absence in that matrix. Chemicals of potential concern solely because of "UJ" data were included in the risk assessment only if they are carcinogens. Thus, the uncertainty surrounding the "UJ" data is handled by inclusion of these data in the quantitative risk assessment for carcinogens. In cases where "UJ" data are included in the quantitative assessment, the SQL (not one-half the SQL) was used because of the probability that the SQL was underestimated in these samples.

5.2 Contaminant Fate and Transport

This section of the risk assessment evaluates the fate and transport of contaminants associated with the site and provides an indication of future contaminant movement. Section 5.1 outlined the occurrence of contamination across the site in surface soil, subsurface soil, ground water, and surface

water. Chemicals of potential concern on site consist mainly of: numerous inorganics and polycyclic aromatic hydrocarbons (PAHs) in the surface and subsurface soils; and inorganics in the ground water.

5.2.1 Potential Routes of Migration

To determine the fate of contaminants of potential concern at the site, information on the physical/chemical and environmental fate properties was collected for site contaminants. This information is presented in Appendix G for selected contaminants of concern. Several of the environmental media studied have the potential for off-site migration, primarily surface soils and ground water. Subsurface soils are not likely to be at risk of transport off-site unless exposed by excavation. Although the subsurface soils contain several chemicals of concern, the mode of transport of the chemicals would be primarily through leaching and ground water transport.

Contaminants in surface soils can migrate or be carried from the site by surface runoff (resulting from precipitation), by the wind in the form of fine particulates sorbed to windblown dust, and by users of the site via vehicle tires, shoes, etc. In addition, contaminants can move from the surface soils (leaving the soils in place) through leaching by infiltration of precipitation and transport by ground water, and volatilization to ambient air. Finally, transport of contaminants to plants or animals which may potentially be consumed by humans is a possible route of migration.

The sampling results have suggested that ground water has been impacted by the site primarily with respect to arsenic and this is evident only in the shallow (as opposed to deep) monitoring wells. The ground water investigations indicate that the site ground water flows in a southwestern or in a western direction depending upon the exact location on-site. There are

no current uses for ground water in the vicinity of the site, but the potential for contaminant migration off-site is evaluated below.

Vapor transport would possibly affect volatile organic compounds observed in subsurface soil and could potentially affect downgradient receptors after transport of VOCs in ground water. However, VOCs are not prevalent in subsurface soil or in ground water at this site. Therefore, off-site migration of VOCs to downgradient receptors is not likely to be an important exposure pathway.

5.2.2 Contaminant Distribution and Observed Migration

The following section examines the contaminants presence across the site, (also discussed in Section 5.1), in combination with the migration pathways (presented in Section 5.2.1), to provide an understanding of contaminant persistence and migration at the site. The discussions below are presented with respect to specific contaminants or contaminant groupings: volatile organic compounds, semi-volatile organic compounds, PCBs, pesticides, and inorganics.

Inorganic Analytes

Many metals have an affinity for soils (particularly clay particles and organic matter in soils) which reduces their mobility. Under extremes of pH, some metals can be rendered mobile. The presence of the inorganic analytes, particularly the naturally occurring elements, must be examined in the context of natural background concentrations, as presented in Table 1-1. No analytes appeared elevated above vs background surface soil levels but in subsurface soil there was a trend for elevated levels of antimony, arsenic, cobalt and nickel. Although the maximum values detected of these analytes were still

within the background range encountered in the U.S., the levels of arsenic found in subsurface soil (geometric mean = 15.4 mg/kg) are considerably higher than that found in surface soil.

All inorganics with the exception of thallium, selenium, antimony, cyanide and mercury were widespread in on site ground water. Comparison of inorganic concentrations in ground water on site to upgradient concentrations indicates that a potential impact has occurred elevating arsenic and perhaps also vanadium above background levels. In the case of arsenic, three monitoring wells appear to be impacted with levels exceeding background by ~10 fold. In order to examine the potential migration of arsenic and vanadium off site, data from monitoring wells MW-10 and MW-11 were compared to on site ground water contamination trends. These monitoring well locations are located on the western border of the site and represent ground water quality as it leaves the site. The arsenic and vanadium levels in these wells were low and similar to the reference well, suggesting that significant off-site migration has not occurred for these agents.

Volatile Organic Compounds

Volatile organic compounds (VOCs) were detected infrequently and at low concentrations in soils on site. VOCs were also not widespread or at high concentrations in ground water or surface water. The principal mechanism for the natural removal of aromatic VOCs is through volatilization (EPA, 1979). Vapor pressures (@ approximately 20°C) of the aromatic hydrocarbons range from 1 to 362 mm Hg and Henry's Law Constants range from 3.97×10^{-5} to 3.84×10^{-1} atm-m³/mol. The role of biodegradation in the natural attenuation of these compounds is compound specific. Similarly the role of adsorption is compound specific (e.g. acetone has little tendency to be retained by soils); the

amount adsorbed is highly related to the amount of organic carbon in the soil and is represented numerically by the organic carbon/water partition coefficient (K_{OC}). The compounds with higher K_{OC} would be preferably partitioned to organic matter in soils and thus would be less likely to be leached from the soils and transported to the ground water. Some aromatic hydrocarbons are highly mobile. Benzene, for example, has a moderate solubility (greater than 1,000 ppm) and low K_{OC} (83 ml/g). Therefore, benzene, because of its tendency to volatilize and biodegrade, would be mobile but would not be expected to be very persistent in the environment. Conversely, xylenes, with their lower solubilities (198 ppm) and higher K_{OC} (240 ml/g), would not be as mobile as benzene, but would be more persistent in the environment as they would tend to sorb to soil particles. The aromatic compounds were not identified in the surface soil samples, probably as a result of their volatility and biodegradation.

Subsurface soils were demonstrated to contain low levels of toluene and tetrachloroethene. Both of these contaminants can bind to soil (K_{OC} = 300-400), and have limited water solubility (0.5-1 mg/ml). These properties suggest that both compounds are not likely to leach downward through soils to the ground water, but rather they may persist in the soil.

VOCs were not present in any ground water samples. In surface water, only two VOCs, carbon tetrachloride and carbon disulfide were detected at one monitoring location. Based upon the low levels detected (\leq 26 ppb) and the fact that detection of these chemicals at other surface water locations or in other matrices did not occur, the detected levels in surface water are not considered highly significant from a migration or exposure perspective.

Semi-Volatile Compounds

The semi-volatile compounds, particularly the PAHs, are persistent in the environment due to their complex chemical nature. Some of the lighter PAHs (fewer aromatic rings) would be subject to biodegradation or volatilization, but the chemical persistence generally increases with increasing number of aromatic rings. Semi-volatile compounds are generally characterized by high boiling point, low vapor pressure, and low solubility (except phenols).

The semi-volatile compounds were not prevalent on this site as they were detected only in surface soil and surface water. Additionally, only one semi-volatile compound, bis(2-ethylhexyl)phthalate, was detected in surface water, and this was at a very low concentration (1 µg/l). In surface soil, the levels of certain PAHs were elevated to levels (6-10 mg/kg) in excess of that typically expected in non-urban zones. Although these PAHs were detected in several locations (40-80% of those sampled), extensive contamination was seen only at SS-2. The presence of PAHs in surface soil but not subsurface soil or ground water may be due to the high sorption capacity ($K_{OC} = 10^4$ to 10^6 ml/g) and low water solubility of these compounds. Therefore, extensive migration from surface soils is not anticipated in the near future.

Pesticides and PCBs

In general, pesticides and PCBs have an affinity for organics in soils (e.g., K_{OC} of DDT is 243,000 ml/g), which tends to render them immobile. In addition, many pesticides and PCBs are very persistent. Migration of these high sorption, low water solubility compounds is very slow unless they occur together with solvents or oils. PCBs were not detected in any media on-site, while the pesticides DDT, aldrin, dieldrin, endrin, and heptachlor were detected at one subsurface soil location at low levels (3-17 µg/kg), and not

in any surface soil samples. DDE was the only pesticide detected in surface soil, and this was at a low concentration (4.5 µg/kg), and at only one location.

These data indicate that pesticides and PCBs are not prevalent and their sporadic appearance in surface or subsurface soils should not lead to substantial migration.

5.3 Exposure Assessment

5.3.1 Development of Exposure Scenarios

The most critical aspect of a technically sound exposure assessment is the identification of plausible exposure routes, together with the identification of human receptors. Based upon site investigations and discussions with field personnel, the following potential current human exposure scenario was identified:

- Persons having access to the site (i.e., nearby residents) may be potential receptors (especially children playing on the site or adults trespassing on the site) with potential exposure to contaminants in surface soil and surface water.

Exposure to contaminants in ground water is not considered a realistic pathway for the current use because no on-site or off-site (downgradient) consumers of ground water exist. Further, there are no downgradient homes which could be impacted by the intrusion of volatile organics emanating from ground water.

Another potential current use exposure pathway is via ingestion of contaminated milk products, since dairy cows graze on the site. The hazard potential associated with this pathway is quite low for the following reasons:

1. Cows graze on-site early in life, before being used for dairy production. Once they are old enough, they are taken off-site for breeding and eventual milk production. Thus, there is a period of at least 10 months duration during which contaminant levels in

bovine tissues would decrease before these cows are used for milk production.

2. Cows do not have access to the most contaminated locations on-site. The oil/water separator region has surface soil levels of certain polycyclic aromatic hydrocarbons that are up to 80 fold greater than that found elsewhere on the site. The oil water separator region is surrounded by physical barriers (low walls and fencing) which humans could easily cross but that cows could not.
3. Milk produced from this dairy herd is diluted by other milk approximately 167 fold during processing and storage (NETC, 1991). Since the upper 90% percentile dairy consumption rate for adults and children (EPA, 1990b) is 0.74 and 4.13 g/kg/day, respectively, the amount of milk consumed from this particular farm is no higher than 4.4 or 24.8 mg/kg/day, respectively (0.6% of total milk consumption).
4. Consumers of milk in the vicinity of the site will not exclusively consume dairy products provided by the distributor using the milk in question. Many brands other than the two which use this source of milk exist, making it unlikely that a consumer will solely use products containing milk from Tank Farm 4.

In combination, these factors indicate that ingestion of milk produced by this particular farmer will be very low, and that the concentrations of contaminants in bovine tissues at the time of milking will also be low. Therefore, the dairy ingestion pathway is of very minor consequence at this site.

Several potential future use exposure pathways exist at the site, including:

- Construction of buildings on the site (i.e., commercial/industrial development of the site), presenting a potential for exposure of construction workers to site contaminants predominantly in subsurface and surface soil.
- Commercial/industrial use of the site, presenting a potential for exposure of employees to contaminants in soil and ground water.
- Residential use of the site, presenting a potential for exposure of adults and children to site contaminants in soil and ground water.

Exposure to sediments is not quantitatively analyzed because review of the monitoring data determined that chemical concentrations in sediments are not greater or materially different than concentrations in soil, and exposure to soil is expected to be greater than to sediments. Therefore, the assessment of risks associated with soil contact is sufficient to also evaluate risks from sediments.

Each scenario includes a particular potential "receptor population", and a consideration of the pathways by which those receptors may encounter contaminants of concern. The values and assumptions used for each exposure scenario were prepared in keeping with generally accepted values in the discipline of risk assessment (EPA, 1989; EPA, 1990); the values are not based on detailed time-activity studies of human behavior.

Specific assumptions and details for each exposure scenario are presented in Appendix D, while the parameter values for each pathway are presented in Table 5-6.

5.3.2 Exposure Scenarios Addressed in the Health Assessment

Scenario 1 - Trespassing Scenario (Current)

Part 1 - Adults: Appendix D of this report presents the model inputs for the exposure routes that trespassing on the site could potentially incur. It is assumed that adults may make 350 visits to the site per year as part of a daily walking routine (e.g., an adult male is known to walk his dog regularly on the site). It is assumed that each visit is an event which could involve a daily amount of soil ingestion and sufficient time for substantial dermal contact with and absorption of soil contaminants. An exposure duration of 30 years for adults is assumed based upon the 90th percentile for length of residence at one location (EPA, 1989).

Trespassers (both adults and children) are assumed to have ready access to specialized regions of the site such as the oil/water separator, and regions overlaying the underground tanks. However, trespassers are not expected to have access to the pump houses or the tank contents because the only point of entry (through the pump house chamber door) is securely closed.

For dermal exposure to surface soil contaminants, it is assumed that adults have a standardized contact rate with soil of 500 mg/day (EPA, Region I, 1989). The percent dermal penetration of contaminants adsorbed to soil varies with the type of chemicals. For volatile organic chemicals, the dermal absorption factor is 50%, while for semi-volatile organic compounds this factor is set at 5% except for low sorption pesticides (50%). Metals and other inorganic compounds are not expected to be absorbed dermally to an extent that could make a substantial contribution to risk.

In addition to dermal exposure, adults are also expected to receive exposure to soil contaminants by ingestion. It is assumed that adults will inadvertently ingest 100 mg soil/day, with 100% of that occurring on site, and that all contaminants in soil will be completely absorbed from the gastrointestinal tract. The mechanisms for inadvertent soil ingestion include hand to mouth contact after contamination of hands from touching dirty clothing, shoes, pets or soil itself.

Adults may contact surface water and thus receive dermal exposure to contaminants in surface water. However, adults are not expected to have extensive recreational use for the streams on-site, and so no surface water ingestion from incidental exposure (splashing, immersion) is expected. As a conservative estimate, adults are modeled to contact surface water on each visit to the site during warm weather months (May-September) for a total of 150 events/year.

Part 2 - Children: Appendix D presents the model inputs for the exposure routes associated with children trespassing and playing on-site. It is assumed that children living within the immediate vicinity of the site may trespass onto it up to 350 days per year, as part of their normal play activities. Although the entire site is fenced, evidence of trespasser activity has been found. Therefore, children may receive dermal and ingestion exposures to contaminants in soil and surface water.

Children would be anticipated to spend only short periods of time on-site after school in the wintertime, but considerably more time could be spent on-site on weekends, and during summer vacation. However, as an upperbound assumption, all visits to the site are considered to involve the daily level of soil ingestion (100 mg/day) and would be of sufficient duration to allow for substantial dermal contact with and dermal absorption of soil contaminants. Children are not likely to enter the site on a regular basis and without adult supervision before the age of 6 years due to the barriers to gaining access to the site (fencing, distance from residences). However, Tank Farm 4 is closer to residences than are other NETC sites and so the age at which children may enter the site is younger at this site (6 years) than at the others (9 years). Regular exposures of this nature are not expected beyond the age of 18 years because of changes in the use of recreational time. Therefore, the exposure duration for children at this site is set at 12 years.

Play activities are expected to involve contact with soil and surface water. Children can play in a stream on-site and thus receive dermal and ingestion exposure to contaminants in surface water. The exposure period associated with surface water is assumed to be 4 hours/day, due mostly to clothing staying wet after water activities have ended. Ingestion of surface

water will be unintentional and very low. As an upper bound, the amount of water ingestion that could be incurred while swimming (50 ml/hour) was assumed to occur for children at this site for a 1 hour period.

Although children are presumed to enter the site 350 days per year, only 150 surface water exposure events per year are modeled. This is because extensive water play is anticipated only for the warm weather months (May-September).

For dermal exposure to soil, children are assumed to have a standardized contact rate with soil (500 mg/day; EPA, Region I, 1989), and dermal penetration of contaminants is modeled as described above for adults. Children are modeled to ingest soil at a rate of 100 mg/day and absorption of soil contaminants after ingestion is assumed to be 100%.

Scenario 2 - Construction Scenario (Future)

Appendix D presents the model equations for the exposure routes that construction workers involved in site development could potentially encounter. Excavation and site preparation activities could cause workers to receive inhalation exposure to contaminants in dust, as well as dermal and ingestion exposures to contaminants in soil. It is assumed that a single construction crew is engaged in the construction of one commercial/industrial complex, with excavation and site preparation activities lasting for a 1 year period (250 work days). It is also assumed that remediation of contaminants would not occur prior to the future occupancy of the site (Residential or Commercial/Industrial Use Scenarios). The inhalation rate for workers (20 m³ per 8 hour work shift) is based upon men undergoing moderate exertion, and dermal exposure is based upon the standardized dermal soil contact rate (500 mg/day). The soil ingestion rate is set at 480 mg/day which is suitable for adults who have extensive contact with soil (EPA, 1991).

Scenario 3 - Commercial/Industrial Scenario (Future)

Future use of the site may involve an commercial/industrial use with workers present 5 days per week, fifty weeks per year for 25 years. Adult employees could become exposed to soil contaminants through entering and leaving the site and due to lunchtime outdoor activities (walks, eating lunch). Soil ingestion is modeled to occur at a rate of 50 mg/day, (EPA, 1991), while dermal exposure to soil is assumed to occur at a rate of 500 mg/day. Ingestion of ground water is modeled to occur at a rate of 1 liter/day since only a portion of the daily water ingestion will occur while on-site. Contact with surface water is not assumed to occur because these receptors are not using the site in a recreational manner.

Scenario 4 - Residential Scenario - Children and Adults (Future)

A future use residential scenario was constructed to evaluate the possible risks associated with residing on the site given the levels of contamination that currently exist.

Appendix D presents the model inputs for the exposure routes that children and adults who live on site might receive. Children, aged 0-6 years, and adults are modeled to receive exposures through soil/house dust ingestion, dermal contact with soil based upon a standardized contact rate with soil (500 mg/day), inhalation of contaminants in dust outdoors from wind erosion, inhalation of volatile organic compounds released into bathroom air during showering, and ingestion of contaminants in drinking water. Dermal contact with contaminants in water during bathing is not considered to be a major potential exposure route (EPA, Region I, 1989), and is thus not modeled. These exposures are assumed to occur on 350 days/year for 6 years for children and 30 years for adults. The time period for exposure to fugitive dust is 24

hours/day as an upperbound estimate since some dust particles will be transported indoors. The exposure period for bathing is 12 minutes/day. Children are assumed to ingest 756 ml water and 200 mg of soil/house dust per day, while for adults, the values of 2 liters of water and 100 mg soil/day are used.

5.3.3 Estimating Environmental Concentrations

All exposure point concentrations used in assessing receptor dose were calculated as specified in Supplemental Risk Assessment Guidance for the Superfund Program (EPA, 1989a).

The contaminant concentration used in the evaluation of on-site health risk was calculated using the geometric mean method as specified by EPA Region I (EPA, 1989a). Because the majority of the data collected showed a log normal distribution, a geometric mean was calculated rather than an arithmetic mean for all media on all sites in this risk assessment. The geometric mean value is typically somewhat lower than the arithmetic mean. However, the exposures are calculated based upon the maximum concentration of an agent detected on-site, as well as for the geometric mean concentration. Therefore, the assessment encompasses the mean level of exposure and risk (average case) and also the upper bound (worst case).

As indicated in the data evaluation section, non-detect values were included in the calculation of exposure point concentrations (i.e., soil concentrations) either as one-half the SQL or as the SQL itself. These non-detected values include detection limits indicated by a "U" qualifier. In general, SQL's were evaluated in light of detection limits and quantifiable ("hits") concentrations of each contaminant. SQLs were independently analyzed and they were incorporated into the quantitative analysis only in those cases

in which the compound was detected in the matrix under consideration or in related matrices.

5.3.4 Evaluating Uncertainty in the Exposure Analysis

Table 5-7 summarizes the assumptions and parameter values used to estimate exposure (i.e., soil ingestion rate, exposure frequency, etc.).

The exposure estimates produced for each receptor in each scenario are based on numerous variables with varying degrees of uncertainty. This discussion will focus on these parameters, and the associated range of uncertainty. Table 5-6 is separated into those parameters which apply to all four scenarios (i.e., global variables), and those which apply specifically to an individual scenario.

- Global Variables (Scenarios 1-4)

Table 5-7 lists the parameters and associated values which are used in each of the three scenarios. Body weight ranges for children (age 6-18 years) were derived from EPA (1990b). The actual value used (43.2 kg) represents an average body weight for this group. Similarly, for children ages 0-6 and adults (18-65 years), a range of body weights is presented, along with the average body weight (14.5 kg and 70 kg, respectively) for the group. While there is a range of body weights for each age group, these ranges are not large, and are not expected to contribute a significant degree of uncertainty to this assessment.

The exposure durations (ED) used for Scenarios 1 and 4 were separated into categories for children and adults. For Scenario 1, children were assumed to spend a duration of twelve years at the site, based upon the age range of children likely to trespass onto the site. In theory, this duration might

range from 1 to 18 years, however, it is unlikely that children younger than 6 years of age would visit the site. For Scenario 4, children ages 0-6 were expected to spend the entire six year time frame on site. The value used is the high end of the proposed range (1-6 years). For Scenarios 1 and 4, adults were assumed to have an ED equal to 30 years, which is the national upper-bound (90th percentile) time at one residence. The ED range is 1-70 years, which spans the expected lifetime. Finally, construction workers (Scenario 2) were expected to have an ED of 1 year, based on the amount of time spent building an commercial/industrial facility at the site.

The ranges associated with ED are only large when considering adults. However, the values used are expected to provide conservative estimates and overstate the potential risk.

Averaging time (AT) which is a pathway specific period of exposure for non-carcinogenic effects, calculated as a product of exposure duration (years) and the number of days/year, is dependent on exposure duration, which was discussed above. AT is not expected to lend a large degree of uncertainty to the exposure estimates.

The ranges of absorption factors (AF) for organic and inorganic compounds vary from no absorption (0) to complete absorption (1). This range is likely to contribute a large degree of uncertainty to the exposure estimates. The values chosen for AF are representative for classes of compounds.

The permeability constant (PC) for each chemical exposed via dermal contact with water was assumed to be equal to the penetration rate of water, rather than on a compound specific basis. Thus, PC may lend a degree of uncertainty in that some compounds will not readily penetrate skin, while others will penetrate at a rapid rate.

The rate of dermal contact with soil was assumed to be 500 mg/day, regardless of the activity or receptor. This value is based upon a relatively small percentage of the total skin surface area exposed to soil contact (1,000 cm² or ~6% for adults and 8% for children). This may be a large underestimate for certain scenarios (e.g., construction workers), particularly at certain times of the year. However, this may be a reasonable approximation on an annualized average basis. The uncertainty surrounding this value is large, possibly spanning an order of magnitude.

The fraction of soil ingested (FI) from the site ranges from 0-1. As a highly conservative estimate, and based on an event-based approach, it was assumed that all soil ingested came from the site.

Finally, concentrations of contaminants in all media were presented as a geometric mean or as the maximum detected concentration. For some chemicals the range of potential concentrations across the site is large, introducing a high degree of uncertainty to the exposure estimates. Since in many cases, "U" data were incorporated into the mean values and "UJ" data were incorporated into the mean and maximum values, the data do not reflect actually detected levels, but a combination of actually undetected and potentially present levels. This way of handling uncertainties regarding exposure concentrations weigh the quantitative assessment towards greater conservatism.

- Scenario 1 - Trespasser Scenario: Current Use

The exposure frequency (EF; days/year) may range from 1 to 365, which may introduce a large degree of uncertainty. The value used (350 days for children and adults) was based on available free time (away from work, school, etc.) when local residents are not away from the region (e.g., not on

vacation). It is assumed that adults may make 350 visits to the site per year as part of a daily walking routine (e.g., an adult male is known to walk his dog regularly on the site). This is an upperbound estimate since illness, bad weather and other limitations would likely lower the number of visits. Exposures to surface water are unlikely to be any greater for children and adults than that modeled. However, lower estimates of EF which may be more likely are not available and so it is prudent to use values reflecting the maximum possible exposure during the warmer months. The soil ingestion rate, 100 mg for 6-18 year old children and adults is a reasonable mean value for these groups. In certain situations, these values could be much higher (e.g., pica children) but using such extreme values would not present a conservative but reasonable estimate of population risk.

- Scenario 2 - Construction Exposure: Future Use

Of the pathways presented in Table 5-7, the inhalation of fugitive dusts is expected to present the largest degree of uncertainty to the exposure estimates. This is because exposure concentrations must be modeled rather than taken from actual site measurements. Exposure point concentrations available for the site include concentrations in soils, sediments and water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) which could occur due to future construction activities are not possible to measure currently, and so exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix D. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith

attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results. Of the remaining parameters, the range for volume inhaled during the work shift is large. The value used is likely to over-predict exposure because it assumes continuous moderate-to-heavy exertion during the entire work shift without any stoppages. The level of soil ingestion used for construction workers is at the upper end of that conceivable for adults, making it likely that the exposure dose from this pathway will not be underestimated.

- Scenario 3 - Commercial/Industrial Scenario: Future Use

Workers at a commercial/industrial facility built on the site may be exposed to contaminants according to the parameters listed in Table 5-7. Exposure parameter values were selected to be lower for this scenario than for the future use/residential scenario because these workers would spend less time on the site, and are not expected to have any recreational use for the site. The parameter values chosen are not expected to introduce a large degree of uncertainty as conservative but reasonable values were selected and the likely parameter value ranges are not very large.

- Scenario 4 - Residential Scenario: Future Use

Of the pathways presented in Table 5-7, inhalation exposures to ambient dust and VOCs emanating from tap water are expected to present the largest degree of uncertainty. This is because exposure concentrations for these pathways could not be directly measured. Exposure point concentrations available at Tank Farm Four include concentrations in soils, sediments and water. However, airborne concentrations of contaminants (i.e., volatilization, fugitive dusts) which might occur in the future could not have

been measured in the field sampling program thus exposure point concentrations must be modeled. Names and citations for the transport models used to estimate exposure point concentrations from laboratory measurements of field samples are given in Appendix D. As a caveat, it is always more accurate to have data for exposure point concentrations in the medium of concern at the exposure point of concern, and the use of transport models represents a good faith attempt to estimate unknown values from known values. However, the use of the models does introduce uncertainty into the results. Other exposure parameters are not expected to introduce major uncertainties into the quantitative assessment, and values were chosen to represent that which is most likely.

5.4 Toxicity Assessment

Appendix F of this report presents a short description of the toxic effects of each chemical of concern, including a summary of the dose-response information pertinent to quantitative risk assessment, as available. Furthermore, Tables F-1 through F-4 present a summary of toxicity values associated with chronic and subchronic noncarcinogenic effects, for the oral and inhalation routes, respectively. Tables F-5 and F-6 summarize the slope factors associated with potential carcinogenic effects of chemicals of concern by the oral and inhalation routes, respectively.

5.5 Risk Characterization

5.5.1 Quantitative Risk Assessment

For potential carcinogens, risks are estimated as probabilities. The compound-specific potency factors for carcinogens are generally estimated through the use of mathematical extrapolation models (e.g., the linearized

multistage model). These models estimate the largest possible linear slope, within a 95% confidence interval, at low extrapolated doses. Thus, the potency factor is characterized as a 95% upperbound estimate, such that the true risk is not likely to exceed the upperbound estimate and may be lower.

The evaluation of risk from noncarcinogenic health hazards is based on the use of RfDs (EPA, 1990; EPA, 1989a). RfDs are estimates of daily exposure to the population (including sensitive subpopulations) that are likely to be without appreciable risk of deleterious effects for the defined exposure period. The RfD is calculated by dividing the no adverse effect level (NOAEL) or lowest observed adverse effect level (LOAEL) derived from animal or human studies by an uncertainty factor, which is multiplied by a modifying factor. RfDs incorporate uncertainty factors which serve as a conservative downward adjustment of the numerical value and reflect scientific judgement regarding the data used to estimate the RfD. For example, a factor of 10 is used to account for variations in human sensitivity (i.e., to protect sensitive subpopulations) when the data stems from human studies involving average, healthy subjects. An additional factor of 10 may also be used for each of the following:

- extrapolation from chronic animal studies to humans,
- extrapolation from a LOAEL to a NOAEL, and
- extrapolation from subchronic to chronic studies.

Finally, based on the level of certainty of the study and database, an additional modifying factor (between zero and ten) may be used.

The results of the quantitative risk analysis are presented in two basic forms. In the case of human health effects associated with exposure to potential carcinogens, risk estimates are expressed as the lifetime

probability of additional cancer risk associated with the given exposure. In numerical terms, these are presented in scientific notation in this report. Thus, a lifetime risk of $1E-04$ means a lifetime incremental risk of one in ten thousand; a lifetime risk of $1E-06$ means an incremental lifetime risk of one in one million and so on.

In the cases of exposure to non-carcinogens, the Hazard Index Ratio is used. As noted in previous sections, the fundamental principles used to construct the RfD utilized in calculating the Hazard Index Ratio are predicated on long term or chronic (usually measured in years) exposures and health effects. However, the RfD used was either the RfD derived from chronic studies (RfD_C) or the RfD which was derived from subchronic studies (RfD_S). Wherever possible, the RfD was matched to the type of exposure (chronic vs subchronic) such that in scenarios involving subchronic exposures (e.g., construction), the RfD_S values were used, and those scenarios involving chronic exposure (trespasser, commercial/industrial use, residential use), the RfD_C values were used.

Cancer and non-cancer health risks are discussed below for trespasser (current use), construction (future use), and residential or commercial/industrial (future use) scenarios. Within the trespasser and residential scenarios, the risks to children (6-18 years old, trespasser/recreational scenario; 0-6 years old, residential scenario) and adults are presented separately. In each case, daily doses of the compounds of concern have been calculated for each exposure pathway modeled, and these doses were then used to calculate cancer risk levels and hazard index ratios. Cancer risk levels are the lifetime probability of excess cancer due to the exposure pathways emanating from use of the site. Cancer risk levels are derived by multiplying exposure dose by the appropriate cancer slope factor

for each compound and exposure route. Non-cancer health risk is quantitated by the hazard index ratio which is the ratio of the exposure dose to the RfD (both in mg/kg/day). The calculated level of cancer risk can be compared to the acceptable total site risk range ($1E-04$ to $1E-06$) for evaluating the need for remediation, as stated in the "National Oil and Hazardous Substances Pollution Contingency Plan, Final Rule" (EPA, 40 CFR Part 300, March 8, 1990) and in the Superfund Human Health Evaluation Manual ($1E-04$ to $1E-07$) (EPA, 1989). Regarding non-carcinogenic health hazards the Superfund Human Health Evaluation Manual (EPA, 1989) states that:

"When the total hazard index for an exposed individual or group of individuals exceeds unity, there may be concern for potential non-cancer health effects."

Thus, the cancer risk and hazard index ratios that constitute a concern are $>1E-04$ and $>1E+00$, respectively. Tables 5-8 through 5-15 summarize cancer risk levels and hazard index ratios for all scenarios.

Cancer risks and hazard index ratios are presented in subsequent sections for each scenario and pathway analyzed. These risk levels are presented as a range in which both the average case value (geometric mean chemical concentrations) and the worst case value (maximum concentration found on-site) are provided. In certain cases, the geometric mean risk value may actually be greater than the maximum risk value because "U" data were included in the geometric mean at one-half the SQL, but "U" data were not included in the formulation of maximum values. This is because it is inappropriate for the maximum risk found on-site to be driven by non-detected values. The maximum values do include "UJ" qualified data at the full SQL. Thus, in those cases where a high SQL for a non-detect is greater than any of the detected levels, it is possible for the geometric mean risk to exceed the maximum risk.

Scenario 1: Trespasser Scenario (Current): Cancer Risks and Hazard Index Ratios

- Children

Tables 5-8 and 5-9 summarize the cancer risks and hazard index ratios for all exposure pathways considered. These tables present risks on a chemical-by-chemical basis so that the major factors which drive the risk can be readily ascertained.

Exposure of children to contaminants while playing on-site is associated with a total cancer risk of $1.8\text{E-}05$ (average case) to $5.4\text{E-}05$ (worst case) which is within the acceptable risk range. The predominant factor contributing to this risk is ingestion of soil contaminants, which is responsible for nearly all of this risk. No single soil contaminant provides a major portion of the risk, but arsenic is responsible for 18%, a variety of PAHs combine to contribute 50%, and the nitrosamine N-nitroso-di-n-propylamine contributes 15%.

It is noteworthy that N-nitroso-di-n-propylamine was not actually detected in surface soil but was incorporated into the quantitative assessment because of "UJ" qualified data. The other major contributors to ingestion risk were actually detected in surface soil.

Other exposure pathways for children in the current use scenario combined to contribute $1\text{E-}06$ (average case and worst case) to cancer risk.

Trespassing/play activities by children on-site are associated with a total hazard index ratio of $1.0\text{E-}01$ in the average with the worst case ratio not materially higher ($1.4\text{E-}01$). These values are below the target HI level. The pathway of most importance to the HI is soil ingestion ($\text{HI} = 8.4\text{E-}02$, average case), and of the chemicals in soil, only thallium, arsenic, and antimony posed a risk as high as $1\text{E-}02$ (average case). However, thallium was

not actually detected in soil, but was present in the analysis due to "UJ" qualified data.

The other exposure pathways (dermal exposure to soil and dermal and ingestion exposure to surface water), in combination, contribute $4\text{E-}03$ (average case) to the HI.

- Adults

Tables 5-8 and 5-9 summarize the cancer risks and hazard index ratios for all exposure pathways considered.

Adults trespassing on the site on a daily basis would experience a total cancer risk of $2.8\text{E-}05$ (average case) to $8.2\text{E-}05$ (worst case) which is within the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$). As for trespassing by children, the vast majority of the risk for adults is derived from the soil ingestion pathway. In the average case, ingestion of arsenic in soil is responsible for a cancer risk of $5\text{E-}06$ while ingestion of carcinogenic PAHs in soil contributes a total risk of $1\text{E-}05$. N-nitroso-di-n-propylamine contributed $4\text{E-}06$ to average case cancer risk, but this risk is based solely upon "UJ" qualified data. The other pathways for adult risk in combination contributed $2\text{E-}06$ (average case).

Use of the site by adults during trespassing is associated with a total hazard index ratio of $5.5\text{E-}02$ (average case) to $6.9\text{E-}02$ (worst case) which is below the upper limit of acceptable HI. Nearly all of the HI comes from ingestion of contaminants in soil. However, as for children, thallium is a major contributor to the HI ($2\text{E-}02$, average case) and this chemical was not definitively identified in surface soil but was included because of "UJ" qualified data.

Scenario 2: Construction Use Scenario (Future): Cancer Risks and Hazard Index Ratios

Table 5-10 summarizes the cancer risks associated with all chemicals and exposure pathways included in this scenario. The total cancer risk level is $2.9\text{E-}06$ (average case) to $4.7\text{E-}06$ (worst case), which is within the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$). Ingestion of arsenic and PAHs combine to form the majority of this risk, while dermal exposure to soil and inhalation of dust-borne contaminants make only minor contributions.

Table 5-11 presents the hazard index ratios for all chemicals and exposure pathways. The total HI is $1.9\text{E-}01$ (average case) to $2.7\text{E-}01$ (worst case), which is below the level of concern for non-carcinogenic effects. The pathway making the largest contribution to HI is soil ingestion, as dermal exposure and inhalation exposures account for only 2% of the HI (average case). Chemicals of most importance to the soil ingestion pathway are metals: antimony (40% of HI), arsenic (25% of HI), and manganese (10% of HI).

Cancer risk levels are lower for construction workers than for receptors in other scenarios because construction workers will be on the site for considerably less time than other receptors. However, the HI levels are slightly higher for construction workers because the dose used to calculate HI is averaged over the exposure period, not the lifetime, and because construction workers are modeled to ingest considerably more soil than other receptors.

Scenario 3: Commercial/Industrial Use Scenario (Future): Cancer Risks and Hazard Index Ratios

Table 5-12 presents the cancer risks for each compound and each exposure pathway associated with the future commercial/industrial use of the site. The total cancer risk for adults working in on-site buildings is $1.3\text{E-}04$ (average

case) to $2.9\text{E-}03$ (worst case). The worst case risk level is well above the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$) but in the average case the level is borderline. The predominant contributor to cancer risk is ingestion of drinking water containing arsenic (~70% of total risk) and beryllium (~14% of total risk). Other carcinogens (volatile or semi-volatile agents) were not detected in ground water. Soil ingestion is associated with a total pathway risk of $7.6\text{E-}06$ (average case), due primarily to PAHs and arsenic in soil. Dermal exposure to soil did not contribute substantially to risk.

Table 5-13 presents the hazard index ratios for each pathway and exposure parameter. The total HI is $1.9\text{E+}00$ (average case) to $1.3\text{E+}01$ (worst case), nearly all of which is caused by ingestion of inorganics in drinking water. The major contributors to this drinking water risk are thallium (~50% of HI), antimony (30% of HI), arsenic (10% of HI) and manganese (20% of HI). It is important to note that the largest contributor to HI, thallium, was not actually detected in ground water, but was included in the assessment because of "UJ" qualified data. Additionally, it should be noted that ground water is not used as a potable source in the area of Tank Farm Four.

Scenario 4: Residential Use Scenario (Future): Cancer Risks and Hazard Index Ratios

- Children

Table 5-14 presents the cancer risks for each compound and each exposure pathway associated with future residential use of the site. The total cancer risk for children residing on site is $2\text{E-}04$ (average case) to $3.7\text{E-}03$ (worst case), which is above the acceptable risk range ($1\text{E-}06$ to $1\text{E-}04$) in both the average and worst cases. The pathways of most importance are ingestion of arsenic and beryllium in drinking water with volatiles, semi-volatiles and pesticides not contributing to risk because they were not detected in

monitoring wells. Additionally, the combined ingestion of carcinogenic PAH compounds and arsenic present in soil cause a combined risk of $5\text{E}-05$ (average case) to $2\text{E}-04$ (worst case), while other compounds and pathways make only minor contributions by comparison.

Table 5-15 presents the hazard index ratios for each compound and exposure pathway. The total HI for children is $1\text{E}+01$ (average case) to $6.5\text{E}+01$ (worst case), which is above that which may constitute a concern ($>1\text{E}+00$) in both the average and worst cases. The most important component of the HI is ingestion of metals in drinking water including thallium ($\text{HI} = 7\text{E}+00$, average case), and manganese ($\text{HI} = 1\text{E}+00$, average case). It is important to note that the driving force for elevation of the HI is thallium, which was not actually detected in ground water, but was included in the assessment due to "UJ" qualified data. However, in the worst case, arsenic makes an important contribution to the HI ($2\text{E}+01$). No other pathway produced an HI level of concern, although the total HI for soil ingestion is $5.1\text{E}-01$ to $6.9\text{E}-01$ (average and worst case, respectively).

- Adults

Table 5-14 presents the cancer risks for each compound and each exposure pathway. The total cancer risk for adults residing on site is $4.3\text{E}-04$ (average case) to $9.8\text{E}-03$ (worst case), which is above the acceptable level ($1\text{E}-06$ to $1\text{E}-04$) in both the average and worst cases. The major contributor to this risk is ingestion of arsenic and beryllium in drinking water, which accounts for over 90% of the total cancer risk. Other pathways which contribute substantially to the cancer risk are ingestion of arsenic and PAHs in soil (risk = $3\text{E}-05$, average case). No cancer risk was caused by the

inhalation of VOCs emanating from tap water since no VOCs were detected in ground water.

Table 5-15 presents the hazard index ratios for each compound and exposure pathway. The total HI for all pathways is $5.4E+00$ (average case) to $3.5E+01$ (worst case), which is greater than the target value of $1E+00$ for HI in both the average and worst cases. Ingestion of chemicals in tap water, most importantly thallium and manganese, accounted for the vast majority of the HI. As pointed out above, the importance of this HI is uncertain due to the fact that the compound contributing most was not actually detected in ground water. However, in the worst case, arsenic did make a major contribution to HI ($1E+01$). No other exposure route had an elevated HI (i.e., $>1E+00$).

Summary of Cancer and Non-Cancer Health Risks

This site currently contains elevated levels of certain key toxicants, which are responsible for driving the risk assessment. The future use residential and commercial/industrial scenarios were associated with the greatest cancer risk and HI levels, due largely to the ingestion of ground water (as tap water) which was absent from the other scenarios. Additionally, the continuous and prolonged (350 days/year for 6 or 30 years) exposure to surface soils (dermal and ingestion) in the residential scenario caused risks to be higher in this scenario than in the others. Inhalation and dermal exposures to contaminants in soil, surface water or tap water were not major exposure pathways.

The chemical in ground water causing the greatest cancer risk is arsenic. Arsenic also increases cancer risks due to soil ingestion to levels as high as $2E-05$ (children in residential scenario, worst case). Arsenic is a group "A" carcinogen, whose carcinogenic effects are most notable in the skin after oral

absorption. While the arsenic oral slope factor for carcinogenic effects is based upon the evidence of human skin cancer, arsenic exposure by the oral route has also been associated with elevated cancer incidences in bladder, lung, liver, kidney and colon (EPA, 1991 - IRIS File). The carcinogenic potency of arsenic upon dermal exposure has not been quantitatively evaluated and for this assessment, dermal exposure to arsenic was assumed to not contribute to the risk of skin cancer. Arsenic also makes substantial contributions to hazard index ratios due to its potency in causing changes in skin (hyperpigmentation, keratosis) (EPA, 1990 - HEAST). However, arsenic made contributions to the HI greater than 1E+00 only under worst case conditions in which it was assumed that residents or workers would be exposed solely to the maximum arsenic concentration detected in ground water. This arsenic concentration (0.45 mg/l) is 32 times greater than the geometric mean arsenic ground water concentration.

Manganese exposure in tap water elevated the HI for both adults and children, particularly in the worst case. The effect of concern for manganese is CNS damage, which has been demonstrated in humans occupationally exposed via the inhalation route. In these studies, internal organ effects for manganese, most notably liver cirrhosis, have also been seen upon chronic inhalation occupational exposure. Manganese is a trace element for which the typical dietary dose is 2-9 mg/day. A dose of 10 mg/day is considered safe (EPA, 1991 - IRIS file). Substantial exposure in drinking water could elevate the dose to a level of concern, particularly because manganese absorption from drinking water is more efficient than that from the diet.

Other contributors to cancer risk at this site are PAH compounds present in soil. Seven carcinogenic PAH compounds, including benzo(a)pyrene, were detected on-site and included in the quantitative risk assessment. All were

assigned the cancer slope factor derived for benzo(a)pyrene, which is among the most potent members of this chemical class. Most carcinogenic members of this class have been shown to induce skin cancer upon topical administration, while the more heavily studied agent, benzo(a)pyrene, has also been shown to cause lung and stomach tumors (ATSDR, 1990). The cumulative cancer risk associated with this group of chemicals was small in relation to arsenic; the highest risk for a particular receptor was 1E-04 (residential scenario - children: soil ingestion, worst case). Dermal cancer risk was not calculated because of uncertainty regarding the carcinogenic potency of these agents by the dermal route. However, given the preponderance of evidence in rodents that these agents are carcinogenic by dermal exposure, it is likely that this analysis underestimates the cancer risk due to PAH compounds present in soil. The increase in cancer risk that could be associated with dermal exposure to PAHs is not likely to be large since the dermal dosage to these agents was generally lower than that received via oral exposure. Thus, the oral exposure risk from PAHs in soil is likely to be substantially greater than the dermal exposure risk.

The major driving force in cancer risk in this risk assessment, ingestion of arsenic is ground water, is driven by higher than background concentrations of arsenic in ground water (see Section 5.1). Elevated arsenic was detected at 3 of 10 monitoring wells with concentrations at the apparently impacted sites in shallow ground water approximately 10-20 fold greater than background. Therefore, elevation of arsenic in ground water appears to be the major risk factor that is possibly attributable to the site.

An additional risk factor is the elevation of PAH compounds to levels of 6-10 mg/kg at one particular surface soil location (vicinity of the oil/water separator). These PAH concentrations are likely due to the historic use of

that portion of the site, and they make a major contribution to soil ingestion risk. However, PAH levels across the rest of the site (at those locations sampled) were not nearly this high suggesting that the extent of PAH contamination of surface soil is very limited.

5.6 Qualitative Analysis of Risks

Selected compounds (see Table 5-5) are addressed qualitatively rather than quantitatively because these compounds were lacking cancer slope factors or RfD values.

It is not possible to include these compounds in the quantitative analysis, and instead, the possible affect they could have on the assessment is discussed qualitatively. The toxicity assessment chemical profiles (Appendix F) discusses the toxic properties of these agents.

Pertinent issues for selected chemicals detected on-site are discussed in more detail below.

Inorganic Compounds

The inorganic compounds aluminum, cobalt, lead, and nickel were detected in various matrices (soil, ground water) but RfD or cancer potency factors are not available to quantitate risks.

Aluminum was present in soil at a geometric mean value of 5,816 mg/kg and the maximum value was 12,200 mg/kg. These values are below the U.S. background mean level of 81,300 mg/kg. Similarly, aluminum levels in ground water did not exceed the background level for this site. Since aluminum is an important dietary constituent and it was not present at elevated concentrations on-site, it does not appear that the lack of an RfD for aluminum substantially affects the outcome of the risk assessment.

Cobalt was present in soils at a geometric mean of 9 mg/kg and a maximum value of 19 mg/kg. These values are similar to background U.S. levels (mean = 9 mg/kg; range is <3-70 mg/kg). Further, cobalt levels in ground water on-site were not elevated relative to the background monitoring well. Therefore, no site-related excessive risks due to cobalt would occur if an RfD were available.

Nickel was present in soil at a geometric mean level of 14 mg/kg and the site maximum was 27 mg/kg. These soil levels are comparable to U.S. background levels (mean = 11 mg/kg; range is 5-700 mg/kg). Additionally, nickel levels in on-site ground water were not elevated above that found in the background monitoring well. Nickel is a carcinogen by the inhalation dose route but it has lacked carcinogenic activity by the oral route. Therefore, the risk due to oral exposure to nickel at this site, while not quantifiable, should not cause a substantial change in the outcome of the risk assessment. The inhalation risk due to nickel exposure in fugitive dusts was quantified in the assessment.

Lead was detected at uniformly low levels across the site (geometric mean = 18 mg/kg; maximum in soil = 40 mg/kg). Lead is generally not given an in-depth risk evaluation at these low environmental levels, especially since other sources of lead (paint, plumbing, dietary sources) could be of greater importance.

Volatile Organic Compounds

The only VOCs detected on-site were carbon tetrachloride and carbon disulfide in surface water, and toluene and tetrachloroethene in soil. These four VOCs have derived RfD or CPF values and so all VOCs detected on-site were quantitatively analyzed.

Semi-Volatile Organics

For all semi-volatile organic compounds detected on-site, RfD or cancer potency factors were available. These were either derived directly by the U.S. EPA (IRIS, 1991) or were derived through extrapolation from other agents sharing important chemical and physical properties. The cases in which these extrapolations were performed and their justification are detailed in the toxicity summary tables provided in Appendix F. The use of these extrapolated values provides a screening level analysis to determine whether inclusion of these chemicals in the quantitative analysis creates substantially greater risk. However, this did not occur, i.e., chemicals with extrapolated values did not drive the risk in any scenario, suggesting that at the concentrations found on-site, these chemicals are not of primary importance.

Pesticides/PCBs

PCBs were not detected in any matrix on-site, while the pesticides DDT, aldrin, dieldrin, endrin, DDE, and heptachlor were each detected at one location and at only low levels. Of this list, only DDE is devoid of an RfD and a cancer potency factor. There is insufficient basis to extrapolate the RfD or cancer potency factor from related compounds (e.g., DDT) to DDE. However, the very low concentrations detected on-site and the infrequency of detection indicate that the missing toxicity values for DDE do not introduce a great deal of uncertainty into the assessment.

Tentatively Identified Compounds (TICs)

TICs are not quantitatively addressed because their chemical identities were poorly characterized. In the vast majority of samples, the TICs are listed as "unknown", "alkane", or "aldol condensate". In the few instances

where a specific chemical is listed as a TIC, the chemical identity was often related to naphthalene (e.g., dimethyl and trimethyl derivatives). This occurred in two surface soil samples. In one, SS-2, the levels of naphthalene derivatives ranged up to 30 mg/kg, and one PAH derivative (dimethyl phenanthrene isomer) was also estimated to be 30 mg/kg. This location, SS-2, had high SQLs together with "UJ" qualified data causing all semi-volatiles to be included in the quantitative assessment at high concentrations (the SQLs). Since these data were included in the semi-volatile soil data base, in a sense, the presence of unknown contaminants appears to have increased the concentrations of semi-volatile compounds used in the analysis, and thus they were indirectly added into the quantitative risk assessment.

5.7 Uncertainty Assessment

- Site-Specific Uncertainty Factors

The scenarios developed for the site include exposures resulting from the probable current use by trespassers and the potential future use of the site as a residential or commercial/industrial area. The risks associated with these scenarios are conditional on these land uses occurring. Observations made during field investigations indicate that trespassing activities have occurred on the site (i.e., local resident frequently walking his dog on site). However, evidence was lacking that the site is used extensively by children or other trespassers. Thus, the uncertainty associated with the exposure frequency and duration for Scenario 1 may be large, and may contribute significantly to an overestimation of risk since extensive daily use of the site was assumed. Current zoning for the site is commercial/industrial, although there is some potential for the site to be used residentially. This uncertainty in future use of the site adds a degree of uncertainty to the risks associated with Scenarios 3 and 4.

Additional uncertainty in the risk characterization may stem from exclusion of chemicals in the quantitative risk assessment. Chemicals which were not included in the quantitative risk assessment were excluded due to either lack of quantitation in the chemical analysis or as a consequence of missing toxicity data.

Chemicals with missing toxicity values are not expected to introduce a large degree of uncertainty into the risk estimates, as described in Section 5.6. Chemicals not detected on-site were omitted from the analysis on the basis that the samples taken include the worst portions of the site. There is uncertainty with regards to the amount of sampling that would be required to verify that the chemical concentrations used presently truly represent the geometric mean and maximum values. However, the monitoring data are consistent and greater levels of some agents were found near zones of likely contamination (arsenic in ground water near tanks; PAHs in soil near the oil/water separator). Thus, the sampling program was successful at identifying points of contamination.

Further evidence that the important points of soil contamination were addressed is the surface soil screening data, which demonstrate that TPH and lead levels across the site are low.

Table 5-16 summarizes the exposure pathways considered for the risk assessment, and the reasons for exclusion or inclusion of particular pathways. Ingestion of ground water from currently used wells downgradient from the site was not addressed as ground water use is not currently possible in this zone. Ingestion of and dermal contact with sediments for current and future land use scenarios was not addressed as these pathways for soil are expected to characterize an equivalent or greater risk. Not only are soils at Tank Farm Four more heavily contaminated than the sediments, but exposures to soils are expected to occur more frequently than exposures to sediments.

Two models were used to characterize exposure point concentrations. The first, a model used to estimate concentrations of chemicals in fugitive dust, was taken from AP-42 (EPA, 1988) (see Appendix D). The key model assumptions include the time frame during which the construction on site is likely to take place and the use of a yearly average wind speed. The potential impact of these assumptions will be to underestimate risk if construction occurs for a longer period of time than originally estimated, or, if daily wind speeds exceed the annual average wind speed. The second model, volatilization of chemicals during home use of ground water (i.e., showering) (see Appendix D) was taken from Andelman (1985). A key assumption for this model is that the fraction of contaminant volatilized is assumed to be 0.9 (90%). This assumption may over-predict VOC indoor levels for various agents.

The primary routes of exposure for Scenarios 1 and 2 are soil ingestion, while ingestion of ground water is the primary route of exposure for Scenarios 3 and 4. Conservative assumptions which may have been driving forces for risk are the frequency with which residents trespass on the site (Scenario 1), the amount of soil ingestion (480 mg/day) and the exposure duration for construction workers (1 year), and the level of ground water ingestion used for Scenarios 3 (1 liter/day) and 4 (2 liter/day - adults; 0.75 liter/day children).

Some significant uncertainties exist in the data used for this site. These uncertainties are likely to overestimate, rather than underestimate, the risk.

A few examples of data uncertainties include:

- "UJ" data (i.e., resulting from matrix effects) were included in calculations of the geometric mean and they were considered as potential locations of contamination.

- Uncertainties in the representative nature of background sampling locations, particularly with regard to inorganic compounds in soil, disallowed exclusion of compounds which may occur naturally at the site.

The effect of adding "UJ" data into the quantitative assessment as if it were actually detected concentrations is dramatically seen in the case of thallium. Thallium exposure in ground water is the major source of hazard ratio (non-cancer risk) in Scenarios 3 and 4. Yet thallium was present in these pathways solely because of "UJ" data and SQL values were not unusually high. Thus, this screening level assessment points out the need to obtain high quality data for chemicals like thallium that have low RfD values. The consequence of having uncertainty surrounding the SQL for such agents is that, in certain cases, uncertainty can drive the estimation of risk.

- Uncertainty Surrounding Cancer and Non-Cancer Risks

For the risk estimation of cancer and of chronic non-cancer health effects, risks from all exposure pathways and for all chemicals have been summated to yield the total site risk for a given receptor. This is a conservative approach, since, in general, different chemicals do not have the same target organ or mechanism of action. Thus, their toxic effects may be, at least in some cases, independent and not additive. Further, chemicals may antagonize one another through competition for enzymes and binding sites, and by inhibition of pathways needed for chemical transport (absorption, cellular uptake, etc.) or metabolic activation. However, it is also possible that certain chemicals can be synergistic such as is the case when a promotor-type carcinogen greatly enhances the expression of genetic damage induced by a low dose of an initiator. The uncertainties surrounding these possibilities are discussed below for the chemicals found on-site.

Cancer Risks

Interactions between carcinogens present at this site may both lead to enhanced and diminished carcinogenic responses. Arsenic, which is responsible for the greatest elevations in cancer risk on-site, is at most only weakly mutagenic, but its carcinogenic effects appear to be mediated through clastogenic effects (ATSDR, 1989). Arsenic-induced chromosomal damage may be due to an impairment of DNA replication or repair, and this effect could facilitate the genotoxic effects of other agents (ATSDR, 1989). Arsenic has been shown to greatly increase the mutagenic effects of direct-acting agents such as UV radiation, and alkylating agents. Further, arsenic appears to increase the production of lung tumors caused by benzo(a)pyrene, and is generally considered to have promotional activity (ATSDR, 1989). The target organ for arsenic's effects after oral ingestion (inhalation of arsenic is not a major concern at this site) is primarily the skin, but elevations in bladder, liver and lung cancer in humans exposed orally to arsenic have also been reported (EPA, 1991 - IRIS File; ATSDR, 1989). Therefore, it appears that arsenic might be able to enhance the carcinogenic action of other genotoxic agents at a variety of target sites.

Of the other carcinogens found on-site, the group of PAH compounds are the most important genotoxic agents. Like arsenic, the PAH compounds exert genotoxic and carcinogenic effects in skin and at internal organs (ATSDR, 1990). The finding that arsenic can enhance lung tumor production by benzo(a)pyrene (ATSDR, 1989) supports the concept that a synergistic action is possible, particularly since arsenic and PAH compounds are found together in soil. Since the skin is an important target site for both the PAH compounds and arsenic, the synergistic effect might be most probable in the skin. Exposure to the skin may occur both directly by dermal contact, and after ingestion of soil or drinking water.

It is of note the beryllium, another carcinogenic metal found in soil, also can produce skin tumors upon oral exposure.

There is evidence that arsenic's toxic, cytogenetic, and carcinogenic effects can be antagonized by selenium, possibly through an interaction at the level of biliary excretion (ATSDR, 1989). However, the selenium content of soils at this site was low and so the quantitative importance of this antagonistic effect is not likely to be substantial.

The carcinogenic PAH compounds are considered to, in general, act similarly with respect to mechanism of action and target organ. However, as a mixture their effects may not be strictly additive due to the potential for co-carcinogenic and antagonistic effects (ATSDR, 1990). These effects appear to be mediated primarily through interference with each other's metabolism - either activation or detoxification, and by inducing activating or detoxifying enzymes. The difference between antagonism, synergism and additivity of carcinogenic effects appears to depend upon the timing of the dosage of the different PAHs, the ratio of the different agents administered, and the exact agents involved (Baird, 1984; Slaga, 1979; Van Duren, 1976). These factors are too complex to allow prediction of the likely outcome from the interaction of PAH compounds at this site. However, this factor does introduce uncertainty in the calculation of cancer risks.

For other carcinogens included in the quantitative analysis, bis(2-ethyl-hexyl)phthalate (DEHP), butylbenzylphthalate, 1,4-dichlorobenzene, and DDT and other chlorinated pesticides, the data suggest a promotional mechanism of action. Since the liver is the primary target organ for several of these agents, and since they may act via distinct mechanisms (e.g., DDT via inhibition of gap junctions; DEHP via peroxisome proliferation) it is possible that additive and even synergistic interactions are possible. Further, these

agents may promote the low dose effects of the genotoxic carcinogens (PAH compounds) to enhance their potency. However, the PAH compounds are not known to cause liver tumors unless the replicative state of the liver is grossly affected, as in partially hepatectomized animals (Marquardt, 1970). Thus, it appears unlikely that the expected weak promotional effects of these agents at this site would substantially increase the carcinogenic potential of PAH compounds in the liver. Further, the low exposure doses possible for promoters at this site call into question whether any promotional action could actually occur. There is considerable uncertainty as to the slope of the dose-response curve for promoters at low doses.

Non-Cancer Effects

The major concern regarding non-cancer effects at this site is due to the potential for ingestion of ground water in the future use (commercial/ industrial and residential) scenarios. For example, the hazard index ratios in the residential scenario for children are $1E+01$ (average case) to $7E+01$ (worst case). Ingestion of thallium contributes ~45% of these HI values, and as mentioned previously, this risk is highly uncertain because thallium was not actually detected on-site, but was included in the assessment due to "UJ" data.

Ingestion of arsenic, manganese, and chromium in drinking water also caused elevated HI values (above $1E+00$) under worst case conditions. The HI associated with chromium is uncertain because of the large uncertainty factor associated with its RfD (500 fold) and because no toxic effects were seen in chronic oral (rat) studies. Further, no adverse effects were seen in humans drinking well water contaminated with 1 mg/l chromium VI for 3 years (IRIS, EPA, 1991), which converts to an approximate adult dosage ($29 \mu\text{g/kg/day}$) that

is 6 times the RfD (5 µg/kg/day). Confidence in chromium VI's RfD is described by EPA as low.

The confidence in the RfD values for arsenic and manganese are considerably greater than that for chromium, since they are based upon effects that have occurred in exposed human populations. The RfD for manganese is based upon its potential for causing CNS damage (substantia nigra neuron degeneration) and behavioral changes as shown in humans exposed via drinking water (EPA 1991 - IRIS File). A toxicant interaction is theoretically plausible between manganese and lead since lead causes a wide variety of electrophysiological and neurochemical changes in the brain (EPA, 1986). Lead has been shown to decrease the synthesis of dopamine in the substantia nigra, which appears to be a primary target site for manganese. Therefore, it is possible that the deleterious effects of lead and manganese on CNS function are additive, or possibly even synergistic. However, this hypothesis has apparently not been tested.

The RfD for arsenic is based upon skin effects in exposed human populations after oral ingestion in drinking water (IRIS, EPA, 1991). Some of the uncertainty regarding arsenic's non-cancer and cancer effects is removed because the toxicity data are from the same matrix (drinking water) that the on-site (future use) exposures could come from. Therefore, matrix effects such as that possible in the case of soil ingestion, are not a factor in evaluating arsenic's potential to produce toxic effects. The same is true for manganese, since, as stated above, evidence for toxic effects comes from cases of humans drinking affected water.

Elevations in the hazard index ratio (above 1E+00) at this site were generally not caused by adding individual HIs for different compounds. Compounds such as thallium, manganese and arsenic were capable of elevating

the HI on their own in the worst case. Therefore, considerations of whether it is appropriate to summate HIs stemming from non-cancer effects that occur in different tissues for different chemicals do not increase the uncertainty in worst case analysis.

In the average case, several sub-threshold doses of different agents combine to elevate the HI. It may be inappropriate to summate across these chemical-specific HI values because of distinctly different target organs (e.g., arsenic - skin; manganese - CNS; thallium - blood enzyme changes). The assumption of additivity of these effects places a conservative emphasis on these analyses.

Uncertainties In The Derivation of Toxicity Values

In numerous cases in which a toxicity value was available for one exposure route but not another, a dose route extrapolation was performed. These extrapolations were utilized to go between the oral and inhalation routes of exposure if the toxic/carcinogenic effects were systemic rather than local. The compounds for which this was done are noted in the tables in Appendix F. The oral to inhalation dose route extrapolation can underestimate potency from inhalation exposure if the chemical is irritating, insoluble, slowly absorbed or highly reactive. Under these conditions, the dose to specific lung regions may be greater than that to the G.I. tract or internal organs, creating the possibility that the lung would be at greater risk. At this site, this possibility is greatest for the oral-to-inhalation extrapolation of RfD values for the metals arsenic, beryllium, nickel and zinc. However, inhalation of these metals was due to the dust inhalation pathway which was a minor exposure route. Therefore, underestimation of toxicity values for inhalation exposure should not have a large effect on the outcome of this risk assessment.

Another form of dose route extrapolation was the use of oral toxicity values for dermal exposure. This extrapolation was utilized for all compounds except PAH compounds, whose potential for dermal effects was discussed. Since PAH compounds are known inducers of skin tumors when applied dermally, their exclusion from the calculation of dermal risk likely causes an underestimation of this risk. However, PAH compounds were markedly elevated at only one surface soil location on-site, and thus the potential for dermal exposure to these agents does not appear to be great.

Similar to the case for PAH compounds, the toxicologic effects of arsenic may be substantial by the dermal route of exposure. Arsenic produces primarily dermal toxicity and carcinogenesis after oral absorption. Since arsenic is readily excreted, it is likely that the amount of arsenic reaching the skin and accumulating there is considerably lower after oral compared to dermal exposure (ATSDR, 1989). Thus, the effectiveness of a dermal dose of arsenic may be as great as if not greater than that after an oral dose. Since this risk assessment excludes dermal exposure to arsenic, it is possible that dermal risks are underestimated. However, the soil ingestion pathway involves considerably more internal exposure than does the dermal pathway, depending upon the degree of dermal vs oral absorption assumed. Thus, if it is assumed that arsenic penetration to sensitive skin and internal organ sites is low by the dermal route, then dermal contact with arsenic will not contribute more risk than does ingestion. However, this assumption is speculative and perhaps under-conservative.

Assignment of the benzo(a)pyrene cancer slope factors to other carcinogenic PAH compounds likely creates a considerable overestimate of risk. Benzo(a)pyrene is one of the most potent PAH compounds (Rugen, 1989; Clement, 1987; EPA, 1985). Other PAH compounds detected on-site, such as

chrysene may be ~200 fold less potent than is benzo(a)pyrene. The data upon which these relative potency estimates are based are taken from primarily dermal studies in which the development of skin tumors was studied. The degree of uncertainty in extrapolating these results to the oral route of exposure in order to adjust the oral slope factor is not known. However, these data are applicable to considerations of the cancer risk from dermal exposure. The overestimation created by using the benzo(a)pyrene slope factor as a surrogate for the other PAH compounds partially offsets the possible underestimation of risk from dermal exposure caused by not adequately characterizing the dermal exposure dose to arsenic and PAH compounds, as described above.

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TABLE 2-1
SUMMARY OF SURFACE SOIL DATA
FOR MCALISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	RANGE OF ON SITE BACKGROUND CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg) ^b	RANGE OF U S BACKGROUND (mg/kg) ^b
INORGANICS								
Aluminum	18/18	(0.2) a	4215-18900	7897	18900.0	8810-15300	33000	7000-100000
Antimony	18/18	8.9-15.8	4.0-81.4	8.8	81.4	5.2-18.9	52	<1-8.8
Arsenic	17/18	0.46	1.9-20	5.19	20.0	5.0-12.2	4.8	1-73
Barium	15/18	11.6-13.3	12-126	20.4	126.0	19.2-82.7	290	10-1500
Beryllium	18/18	(0.005) a	0.18-1.7	0.47	1.7	0.45-0.61	55	1-7
Cadmium	7/18	0.545-0.58	0.5-2	0.74	21.8	0.90	NA	NA
Calcium	18/18	(5.0) a	568-45500	2256	45500.0	887-3710	340000	10000-280000
Chromium	18/18	(0.01) a	5.2-69.2	18.3	69.2	11.4-26.2	53	1-1000
Cobalt	17/18	9.2	3.6-20.2	9.38	20.2	8.8-13.8	5.9	3-70
Copper	18/18	(0.025) a	13.4-8070	85.2	8070.0	27.2-563	13	1-700
Cyanide	2/18	0.53-0.87	0.61-0.87	0.35	0.7	<0.79	NA	NA
Iron	18/18	(0.1) a	5510-78000	24433	78000.0	18700-29400	14000	100-100000
Lead	18/18	(0.005) a	7.3-1980	98.8	1980.0	283-1880	14	10-300
Magnesium	18/18	(5.0) a	311-5800	2627	5800.0	2270-4440	210000	50-50000
Manganese	18/18	(0.015) a	217-678	363	678.0	160-578	280	2-7000
Mercury	3/18	0.12-0.16	0.14-1.8	0.10	1.8	<0.18	0.81	0.1-3.4
Nickel	18/18	(0.04) a	3.4-105	21.5	105.0	14.4-35.5	11	5-700
Potassium	5/18	193.5-1030	148-912	216	912.0	292	7500	50-37000
Selenium	10/18	0.39-0.58	0.35-2	0.36	2.0	0.56-0.63	3	1-3.9
Silver	5/18	0.54-0.95	0.44-32.3	0.50	32.3	<0.91	NA	NA
Sodium	3/18	54-228	425-468	73	468.0	<228	2500	500-50000
Thallium	9/18	0.7-11.4	0.775-1.2	0.83	1.2	0.98-1.0	7.7	2.2-23
Vanadium	18/18	(0.05) a	11-269	36.9	269.0	18.3-42.4	43	7-300
Zinc	18/18	(0.02) a	38.1-19200	245	19200.0	174-276	40	5-2900
VOLATILES								
1,1-Dichloroethane	1/18	0.005-0.012	0.009	0.0031	0.009	40	NA	NA
1,1-Dichloroethene	1/18	0.005-0.012	0.009	0.0037	0.009	40	NA	NA
1,1,1-Trichloroethane	4/18	0.005-0.012	0.0035-0.009	0.0041	0.009	40	NA	NA
1,1,2-Trichloroethane	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
1,1,2,2-Tetrachloroethane	6/18	0.005-0.012	0.006-0.012	0.0046	0.012	40	NA	NA
1,2-Dichloroethane	1/18	0.005-0.012	0.009	0.0037	0.009	40	NA	NA
1,2-Dichloroethene	1/18	0.005-0.012	0.009	0.0037	0.009	40	NA	NA
1,2-Dichloropropane	2/18	0.005-0.012	0.006-0.009	0.0040	0.009	40	NA	NA
1,3-Dichloropropane (Cis)	2/18	0.005-0.012	0.006-0.009	0.0041	0.009	40	NA	NA
1,3-Dichloropropane (Trans)	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
2-Butanone	NA	NA	NA	NA	0.000	NA	NA	NA
2-Hexanone	5/18	0.01-0.0205	0.014-0.025	0.0091	0.025	79	NA	NA
4-Methyl-2-Pentanone	2/18	0.01-0.0125	0.014-0.025	0.0072	0.015	79	NA	NA
Acetone	8/18	0.01-0.062	0.002-0.025	0.0064	0.025	<440	NA	NA
Benzene	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Bromodichloromethane	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Bromoform	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Bromomethane	1/18	0.1-0.025	0.017	0.0078	0.017	79	NA	NA
Carbon disulfide	1/18	0.005-0.012	0.009	0.0037	0.009	40	NA	NA
Carbon Tetrachloride	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Chlorobenzene	5/18	0.005-0.0105	0.002-0.012	0.0043	0.012	40	NA	NA
Chloroethane	1/18	0.01-0.025	0.017	0.0078	0.017	79	NA	NA
Chloroform	1/18	0.005-0.012	0.009	0.0037	0.009	40	NA	NA
Chloromethane	4/18	0.011-0.025	0.01-0.017	0.0067	0.017	79	NA	NA
Dibromochloromethane	2/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Ethylbenzene	5/18	0.005-0.0105	0.006-0.012	0.0043	0.012	40	NA	NA
Methylene chloride	1/18	0.006-0.033	0.009	0.0026	0.009	<75	NA	NA
Styrene	6/18	0.005-0.0105	0.006-0.012	0.0046	0.012	40	NA	NA
Tetrachloroethane	6/18	0.005-0.0105	0.002-0.012	0.0041	0.012	40	NA	NA
Toluene	6/18	0.005-0.0105	0.002-0.012	0.0040	0.012	40	NA	NA
Trichloroethane	3/18	0.005-0.012	0.006-0.009	0.0039	0.009	40	NA	NA
Vinyl acetate	2/18	0.01-0.025	0.015-0.017	0.0079	0.017	79	NA	NA
Vinyl chloride	1/18	0.01-0.025	0.015-0.017	0.0078	0.017	79	NA	NA
Xylenes	6/18	0.005-0.0105	0.006-0.012	0.0046	0.012	40	NA	NA

a SQLs in parenthesis are the contract required quantitation limits (CQRL)
b U.S. background range and average concentration are from (USGS, 1984)
NA Not Applicable

TABLE 2-1 (cont.)
SUMMARY OF SURFACE SOIL DATA
FOR MCALISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	RANGE OF ON SITE BACKGROUND CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
SEMIVOLATILES								
1,2-Dichlorobenzene	1/16	0.37-7.9	44	0.440	0.440	580	NA	NA
1,2,4-Trichlorobenzene	1/16	0.37-7.9	44	0.440	0.440	580	NA	NA
1,3-Dichlorobenzene	1/16	0.37-7.9	44	0.440	0.440	580	NA	NA
1,4-Dichlorobenzene	1/16	0.16-7.9	44	0.440	0.440	580	NA	NA
2-Chloronaphthalene	1/16	0.37-7.9	44	0.440	0.440	580	NA	NA
2-Chlorophenol	1/16	0.37-7.9	44	0.440	0.440	580	NA	NA
2-Methylnaphthalene	3/16	0.37-7.9	0.096-1.1	0.265	1.100	400	NA	NA
2-Methylphenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2-Nitroaniline	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
2-Nitrophenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2,4-Dichlorophenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2,4-Dimethylphenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2,4-Dinitrophenol	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
2,4-Dinitrotoluene	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2,4,5-Trichlorophenol	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
2,4,6-Trichlorophenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
2,6-Dinitrotoluene	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
3-Nitroaniline	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
3,3'-Dichlorobenzidine	2/16	0.74-8.0	0.87-16.0	0.773	16.000	<1200	NA	NA
4-Bromophenyl-phenylether	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
4-Chloro-3-methylphenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
4-Chloroaniline	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
4-Chlorophenyl-phenylether	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
4-Methylphenol	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
4-Nitroaniline	1/16	1.9-40.0	44	2.200	2.200	<2900	NA	NA
4-Nitrophenol	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
4,6-dinitro-2-methylphenol	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
Acenaphthene	9/16	0.37-0.56	0.11-3.8	0.321	3.800	<580	NA	NA
Acenaphthylene	2/16	0.37-7.9	0.44-0.052	0.340	0.440	<580	NA	NA
Anthracene	12/16	0.37-0.56	0.044-8.6	0.385	8.600	<580	NA	NA
Benzic acid	2/16	0.39-40.0	0.38-2.2	1.390	2.200	<2900	NA	NA
Benzo(a)anthracene	16/16	(0.33)a	0.052-16.0	0.695	16.000	99	NA	NA
Benzo(a)pyrene	15/16	0.48	0.44-16.0	0.636	16.000	71	NA	NA
Benzo(b)fluoranthene	15/16	0.48	0.12-15.0	0.943	15.000	78	NA	NA
Benzo(ghi)perylene	14/16	0.425-0.48	0.2-8.4	0.735	8.400	60	NA	NA
Benzo(k)fluoranthene	15/16	0.48	0.119-14.0	0.841	14.000	62	NA	NA
Benzyl Alcohol	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Bis(2-chloroethoxy)methane	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Bis(2-chloroethyl) ether	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Bis(2-chloroisopropyl) ether	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Bis(2-ethylhexyl)phthalate	3/16	0.12-3.0	0.44-7.9	0.368	7.900	<580	NA	NA
Butylbenzylphthalate	3/16	0.059-3.0	0.44-7.9	0.281	7.900	<580	NA	NA
Chrysene	16/16	(0.33)a	0.072-16.0	0.621	16.000	150	NA	NA
Dibenzofuran	7/16	0.37-7.9	0.05-2.8	0.274	2.800	<580	NA	NA
Dibenzo(a,h)anthracene	11/16	0.4-0.56	0.074-7.9	0.428	7.900	<580	NA	NA
Diethylphthalate	2/16	0.19-7.9	0.275	0.325	0.440	<580	NA	NA
Dimethylphthalate	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Di-n-butylphthalate	1/16	0.27-3.2	0.44	6.700	6.700	<580	NA	NA
Di-n-octylphthalate	4/16	0.38-3.0	0.37-7.9	0.421	7.900	<580	NA	NA
Fluoranthene	16/16	(0.33)a	0.17-46.0	1.395	46.000	200	NA	NA
Fluorene	9/16	0.37-0.48	0.09-4.7	0.329	4.700	120	NA	NA
Hexachlorobenzene	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Hexachlorobutadiene	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Hexachlorocyclopentadiene	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Hexachloroethane	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Indeno(123cd)pyrene	14/16	0.425-0.48	0.16-8.9	0.718	8.900	81	NA	NA
Isophorone	1/16	0.37-7.9	44	0.440	0.440	<580	NA	NA
Naphthalene	5/16	0.37-7.9	0.044-3.0	0.312	3.000	190	NA	NA
Nitrobenzene	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
N-nitroso-di-n-propylamine	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
N-nitrosodiphenylamine	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Pentachlorophenol	1/16	1.9-40.0	2.2	2.200	2.200	<2900	NA	NA
Phenanthrene	16/16	(0.33)a	0.060-26.0	0.849	26.000	510	NA	NA
Phenol	1/16	0.37-7.9	0.44	0.440	0.440	<580	NA	NA
Pyrene	15/16	(0.33)a	0.096-27.0	1.261	27.000	230	NA	NA
PESTICIDES								
4,4'-DDD	3/16	0.016-0.24	0.019-0.19	0.026	0.190	<25	NA	NA
4,4'-DDE	4/16	0.016-0.24	0.0107-0.024	0.021	0.024	<25	NA	NA
4,4'-DDT	11/16	0.083-0.24	0.007-1.8	0.041	1.800	<25	NA	NA
Aldrin	1/16	0.016-0.24	0.0095	0.010	0.010	<13	NA	NA
Alpha-BHC	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Alpha-chlordane	1/16	0.08-1.2	0.095	0.095	0.095	<130	NA	NA
Beta-BHC	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Delrin	1/16	0.016-0.24	0.019	0.019	0.019	<25	NA	NA
Delta-BHC	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Endosulfan I	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Endosulfan II	1/16	0.016-0.24	0.019	0.019	0.019	<25	NA	NA
Endosulfan Sulfate	1/16	0.016-0.24	0.019	0.019	0.019	<25	NA	NA
Endrin	1/16	0.016-0.24	0.019	0.019	0.019	<25	NA	NA
Endrin ketone	1/16	0.016-0.24	0.019	0.019	0.019	<25	NA	NA
Gamma-BHC	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Gamma-chlordane	1/16	0.08-1.2	0.095	0.095	0.095	<130	NA	NA
Heptachlor	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Heptachlor epoxide	1/16	0.006-0.12	0.0095	0.010	0.010	<13	NA	NA
Methoxychlor	1/16	0.08-1.2	0.095	0.095	0.095	<130	NA	NA
Toxaphene	1/16	0.16-2.4	19	0.190	0.190	<250	NA	NA
PCB's								
Aroclor-1016	1/16	0.06-1.2	0.095	0.095	0.090	<130	NA	NA
Aroclor-1221	1/16	0.06-1.2	0.095	0.095	0.095	<130	NA	NA
Aroclor-1232	1/16	0.06-1.2	0.095	0.095	0.095	<130	NA	NA
Aroclor-1242	1/16	0.06-1.2	0.095	0.095	0.095	<130	NA	NA
Aroclor-1246	1/16	0.06-1.2	0.095	0.095	0.095	<130	NA	NA
Aroclor-1254	5/16	0.16-2.4	0.13-0.61	0.220	0.610	<75	NA	NA
Aroclor-1260	1/16	0.16-2.4	0.19	0.190	0.190	<250	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQL).
b. U.S. background range and average concentration are from (USGS, 1984)
NA. Not Applicable

TABLE 2-2
SUMMARY OF SUBSURFACE SOIL DATA
MCALLISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
INORGANICS							
Aluminum	28/28	(0.2)a	2710-28100	28100	8679	33000	7000-100000
Antimony	11/28	3.7-29.2	3.5-167	167	4.91	0.52	<1-8.8
Arsenic	27/28	4.1	2-22.9	22.9	8.40	4.8	0.1-73
Barium	25/28	2.9-12	7.9-214	214	17.7	290	10-1500
Beryllium	12/28	0.22-0.69	0.33-2	2	0.32	0.56	1-7
Cadmium	8/28	0.48-0.69	0.57-8.6	8.6	0.45	0.26 c	NA
Calcium	27/28	279	308-14000	14000	1418	3400	100-280000
Chromium	28/28	(0.01)a	4.7-78.1	78.1	15.3	33	1-1000
Cobalt	28/28	(0.06)a	1.5-28	28	10.3	5.9	0.3-70
Copper	28/28	5-7.9	11-1760	1760	34.8	13	1-700
Cyanide	3/28	0.63-0.89	0.53-0.81	0.59	0.33	NA	NA
Iron	28/28	(0.1)a	5840-50000	50000	23566	14000	100-100000
Lead	28/28	(0.006)a	2.1-886	886	33.0	14	10-300
Magnesium	28/28	(5.0)a	809-7640	7640	2365	2100	50-50000
Manganese	28/28	(0.015)a	45.5-1300	1300	340	260	2-7000
Mercury	12/28	0.1-0.14	0.11-2.9	2.9	0.11	0.061	0.01-3.4
Nickel	28/28	(0.04)a	2.7-88.3	88.3	19.4	11	5-700
Potassium	12/28	129-560	137-812	705	161	12000	50-37000
Selenium	17/28	0.32-0.97	0.33-4.2	4.2	0.37	0.3	0.1-3.9
Silver	11/28	0.54-18	0.48-16.1	16.1	0.91	NA	NA
Sodium	10/28	19.7-144	17.3-677	677	48.8	2500	500-50000
Thallium	0/28	0.20-0.95	NA	NA	NA	7.7	2.2-23
Vanadium	23/28	8.3-31.9	6.8-221	221	23.50	43	7-300
Zinc	28/28	(0.02)a	18.3-2090	2090	114.29	40	5-2900
VOLATILES							
1,1-Dichloroethane	5/28	0.005-0.870	0.003-0.008	0.008	0.0048	NA	NA
1,1-Dichloroethane	5/28	0.005-0.870	0.006	0.008	0.0047	NA	NA
1,1,1-Trichloroethane	9/28	0.005-0.870	0.003-0.010	0.01	0.0063	NA	NA
1,1,2-Trichloroethane	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
1,1,2,2-Tetrachloroethane	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
1,2-Dichloroethane	5/28	0.005-0.870	0.006	0.008	0.0047	NA	NA
1,2-Dichloroethane	8/28	0.005-0.730	0.006-0.34	0.34	0.0047	NA	NA
1,2-Dichloropropane	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
1,3-Dichloropropane (Cis)	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
1,3-Dichloropropane (Trans)	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
2-Butanone	4/28	0.010-0.012	0.011-0.023	0.023	0.0089	NA	NA
2-Hexanone	9/28	0.010-1.7	0.011-0.023	0.023	0.0103	NA	NA
4-Methyl-2-Pentanone	4/28	0.010-1.7	0.011-0.013	0.013	0.0101	NA	NA
Acetone	5/28	0.010-1.7	0.011-0.012	0.012	0.0230	NA	NA
Benzene	7/28	0.005-0.870	0.004-0.008	0.008	0.0049	NA	NA
Bromodichloromethane	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
Bromoform	10/28	0.005-0.870	0.005-0.012	0.012	0.0054	NA	NA
Bromomethane	5/28	0.010-1.7	0.012-0.013	0.013	0.0095	NA	NA
Carbon disulfide	8/28	0.005-0.870	0.001-0.008	0.008	0.0045	NA	NA
Carbon Tetrachloride	7/28	0.005-0.870	0.006	0.008	0.0060	NA	NA
Chlorobenzene	8/28	0.005-0.870	0.001-0.032	0.032	0.0049	NA	NA
Chloroethane	5/28	0.010-1.7	0.012-0.013	0.013	0.0095	NA	NA
Chloroform	5/28	0.005-0.870	0.003-0.008	0.008	0.0048	NA	NA
Chloromethane	8/28	0.010-0.023	0.012-1.7	1.7	0.0102	NA	NA
Dibromochloromethane	8/28	0.005-0.870	0.006-0.012	0.012	0.0061	NA	NA
Ethylbenzene	13/28	0.005-0.870	0.002-0.38	0.38	0.0081	NA	NA
Methylene chloride	0/28	0.008-0.033	NA	NA	NA	NA	NA
Styrene	7/28	0.005-0.870	0.006	0.008	0.0050	NA	NA
Tetrachloroethene	10/28	0.005-0.870	0.002-0.38	0.38	0.0048	NA	NA
Toluene	15/28	0.005-0.870	0.001-0.68	0.68	0.0060	NA	NA
Trichloroethene	13/28	0.005-0.870	0.001-0.240	0.008	0.0045	NA	NA
Vinyl acetate	9/28	0.010-0.023	0.011-0.013	0.013	0.0085	NA	NA
Vinyl chloride	5/28	0.010-1.7	0.012-0.013	0.013	0.0095	NA	NA
Xylenes	13/28	0.005-0.870	0.003-0.73	0.73	0.0082	NA	NA

a SQLs in parenthesis are the contract required quantitation limits (CQRL)
b U.S. background range and average concentration are from (USGS, 1984)
c Average U.S. background (Carey, 1979)
NA Not Applicable

TABLE 2-2 (cont.)
SUMMARY OF SUBSURFACE SOIL DATA
MCALLISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SOL (mg/kg)	RANGE OF DETECTION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
SEMIVOLATILES							
1,2-Dichlorobenzene	12/26	0.36-2.2	0.39-2.7	2.7	0.421	NA	NA
1,2,4-Trichlorobenzene	13/26	0.36-2.2	0.39-2.7	2.7	0.449	NA	NA
1,3-Dichlorobenzene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
1,4-Dichlorobenzene	14/26	0.36-11.0	0.06-2.2	2.2	0.413	NA	NA
2-Chloronaphthalene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2-Chlorophenol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2-Methylnaphthalene	20/26	0.36-2.2	0.06-4.6	4.6	0.393	NA	NA
2-Methylphenol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2-Nitroaniline	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
2-Nitrophenol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2,4-Dichlorophenol	16/26	0.36-2.2	0.064-2.7	2.7	0.388	NA	NA
2,4-Dimethylphenol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2,4-Dinitrophenol	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
2,4-Dinitrotoluene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2,4,6-Trichlorophenol	14/26	1.8-11.0	0.11-14.0	14	2.00	NA	NA
2,4,6-Trichlorophenol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
2,6-Dinitrotoluene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
3-Nitroaniline	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
3,3'-Dichlorobenzidine	13/26	0.72-4.6	0.785-6.4	6.4	0.87	NA	NA
4-Bromophenyl-phenylether	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
4-Chloro-3-methylphenol	13/26	0.36-2.2	0.39-2.7	2.7	0.436	NA	NA
4-Chloroaniline	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
4-Chlorophenyl-phenylether	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
4-Methylphenol	17/26	0.36-2.2	0.069-6.8	6.8	0.441	NA	NA
4-Nitroaniline	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
4-Nitrophenol	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
4,6-dinitro-2-methylphenol	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
Acenaphthene	18/26	0.36-2.2	0.067-6.8	6.8	0.372	NA	NA
Acenaphthylene	17/26	0.36-2.2	0.068-2.7	2.7	0.382	NA	NA
Anthracene	17/26	0.36-2.2	0.067-2.7	2.7	0.362	NA	NA
Benzoic acid	18/26	1.8-11.0	0.84-14.0	14	2.26	NA	NA
Benzo(a)anthracene	23/26	0.46-2.2	0.044-3.7	3.7	0.461	NA	NA
Benzo(a)pyrene	20/26	0.36-2.2	0.073-3.2	3.2	0.434	NA	NA
Benzo(b)fluoranthene	22/26	0.46-2.2	0.06-2.7	2.7	0.411	NA	NA
Benzo(g,h)perylene	18/26	0.36-2.2	0.067-2.7	2.7	0.467	NA	NA
Benzo(k)fluoranthene	21/26	0.36-2.2	0.052-2.9	2.9	0.429	NA	NA
Benzyl Alcohol	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Bis(2-chloroethoxy)methane	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Bis(2-chloroethyl)ether	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Bis(2-chloroisopropyl)ether	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Bis(2-ethoxyethyl)phthalate	18/26	0.36-2.1	0.11-12.0	12	0.493	NA	NA
Butylbenzylphthalate	13/26	0.36-2.2	0.31-2.7	2.7	0.449	NA	NA
Chrysene	23/26	0.46-2.2	0.06-3.6	3.6	0.434	NA	NA
Dibenzofuran	18/26	0.36-2.2	0.043-4.0	4	0.360	NA	NA
Dibenzo(a,h)anthracene	16/26	0.36-2.2	0.3-2.7	2.7	0.480	NA	NA
Dibenzophthalate	16/26	0.36-2.2	0.046-2.7	2.7	0.393	NA	NA
Dimethylphthalate	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Di-n-butylphthalate	11/26	0.33-2.2	0.046-6.7	4.1	0.396	NA	NA
Di-n-octylphthalate	16/26	0.36-2.2	0.096-2.7	2.7	0.424	NA	NA
Fluoranthene	24/26	0.46-2.2	0.047-5.9	5.9	0.715	NA	NA
Fluorene	18/26	0.36-2.2	0.044-4.4	4.4	0.347	NA	NA
Hexachlorobenzene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Hexachlorobutadiene	14/26	0.36-2.2	0.39-2.7	2.7	0.450	NA	NA
Hexachlorocyclopentadiene	13/26	0.36-2.2	0.39-2.7	2.7	0.450	NA	NA
Hexachloroethane	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Indeno(123c,d)pyrene	16/26	0.36-2.2	0.21-2.7	2.7	0.478	NA	NA
Isophorone	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Naphthalene	20/26	0.36-2.2	0.047-3.0	3	0.351	NA	NA
Nitrobenzene	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
N-nitroso-di-n-propylamine	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
N-nitrosodiphenylamine	13/26	0.36-2.2	0.39-2.7	2.7	0.438	NA	NA
Pentachlorophenol	13/26	1.8-11.0	1.96-14.0	14	2.18	NA	NA
Phenanthrene	23/26	0.36-0.45	0.06-6.2	6.2	0.688	NA	NA
Phenol	12/26	0.36-2.2	0.15-2.7	2.7	0.407	NA	NA
Pyrene	24/26	0.46-2.2	0.046-4.4	4.4	0.631	NA	NA
PESTICIDES							
4,4-DDD	22/26	0.018-0.02	0.0033-0.2	0.2	0.023	NA	NA
4,4'-DDE	18/26	0.016-0.092	0.0023-0.2	0.2	0.018	NA	NA
4,4'-DDT	16/26	0.016-0.092	0.0044-0.3	0.3	0.022	NA	NA
Aldrin	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Alpha-BHC	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Alpha-chlordane	18/26	0.06-0.46	0.0845-1.0	1	0.123	NA	NA
Beta-BHC	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Deltrin	18/26	0.016-0.092	0.017-0.2	0.2	0.024	NA	NA
Delta-BHC	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Endosulfan I	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Endosulfan II	18/26	0.016-0.092	0.017-0.2	0.2	0.024	NA	NA
Endosulfan Sulfate	18/26	0.016-0.092	0.017-0.2	0.2	0.024	NA	NA
Endrin	18/26	0.016-0.092	0.017-0.2	0.2	0.024	NA	NA
Endrin ketone	18/26	0.016-0.092	0.017-0.2	0.2	0.024	NA	NA
Gamma-BHC	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Gamma-chlordane	18/26	0.06-0.46	0.0845-1.0	1	0.123	NA	NA
Heptachlor	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Heptachlor epoxide	18/26	0.006-0.046	0.0085-0.1	0.1	0.012	NA	NA
Methoxychlor	18/26	0.06-0.46	0.0845-1.0	1	0.123	NA	NA
Toxaphene	18/26	0.16-0.92	0.087-2.0	2	0.244	NA	NA
PCB's							
Aroclor-1016	18/26	0.08-0.46	0.0845-1.0	1	0.123	NA	NA
Aroclor-1221	18/26	0.08-0.46	0.0845-1.0	1	0.123	NA	NA
Aroclor-1232	18/26	0.08-0.46	0.0845-1.0	1	0.123	NA	NA
Aroclor-1242	18/26	0.08-0.46	0.044-1.0	1	0.147	NA	NA
Aroclor-1248	17/26	0.08-0.46	0.0845-1.0	1	0.128	NA	NA
Aroclor-1254	17/26	0.16-0.92	0.025-2.0	2	0.200	NA	NA
Aroclor-1260	18/26	0.16-0.92	0.17-2.0	2	0.244	NA	NA

a. SOLs in parenthesis are the contract required quantitation limits (CQL)
b. U.S. background range and average concentration are from (USGS, 1984)
c. Average U.S. background (Carey, 1978)
NA Not Applicable

TABLE 2-3
SUMMARY OF MONITORING WELL DATA
AT MCALLISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/L)	RANGE OF DETECTION (mg/L)	MAXIMUM CONCENTRATION (mg/L)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/L)	ON SITE BACKGROUND CONCENTRATIONS (mg/L) ^b
INORGANICS						
Aluminum	10/10	(0.2)a	0.412-284	284	28.69	3.27
Antimony	8/10	22-30.4	0.022-0.259	0.259	0.037	0.022
Arsenic	10/10	(0.01)a	0.021-0.0694	0.0694	0.029	0.054
Barium	7/10	200	0.005-1.77	1.77	0.169	<0.2
Beryllium	6/10	1	0.002-0.0128	0.0128	0.0022	0.001
Cadmium	10/10	(0.005)a	0.003-0.0571	0.0571	0.0061	0.003
Calcium	10/10	(5.0)a	9.030-139	139	39.44	10.1
Chromium	4/10	10	0.0189-0.248	0.248	0.030	<0.01
Cobalt	6/10	4	0.0223-0.737	0.737	0.058	0.044
Copper	5/10	25-47.6	0.0573-3.16	3.16	0.145	<0.031
Cyanide	2/10	10	0.010	0.01	0.0057	<0.01
Iron	10/10	(0.1)a	0.702-537	537	83.16	56.8
Lead	10/10	(0.005)a	0.003-4.8	4.8	0.081	0.042
Magnesium	10/10	(5.0)a	4.89-89.2	89.2	38.42	9.42
Manganese	10/10	(15.0)a	0.0578-21	21	3.22	1.14
Mercury	5/10	0.2	0.00032-0.0084	0.0084	0.0004	<0.02
Nickel	10/10	(0.04)a	0.0167-0.678	0.678	0.150	0.04
Potassium	10/10	(5.0)a	1.6-31.7	31.7	8.59	1.07
Selenium	1/10	2.0	0.0025	0.0025	0.0014	NA
Silver	2/10	3.0-22.5	0.0266-0.126	0.126	0.0038	<0.003
Sodium	10/10	(5.0)a	9.75-238	238	36.10	14.9
Thallium	2/10	4-40	0.004-0.04	0.04	0.0043	<0.004
Vanadium	1/10	50-102	0.109	0.109	0.036	<0.05
Zinc	9/10	20.5	0.168-12.1	12.1	0.56	0.105
VOLATILES						
1,1-Dichloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
1,1-Dichloroethene	1/10	0.005	0.005	0.005	0.003	<0.005
1,1,1-Trichloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
1,1,2-Trichloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
1,1,2,2-Tetrachloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
1,2-Dichloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
1,2-Dichloroethene	1/10	0.005	0.005	0.005	0.003	<0.005
1,2-Dichloropropane	1/10	0.005	0.005	0.005	0.003	<0.005
1,3-Dichloropropene (Cis)	1/10	0.005	0.005	0.005	0.003	<0.005
1,3-Dichloropropene (Trans)	1/10	0.005	0.005	0.005	0.003	<0.005
2-Butanone	1/10	0.01	0.01	0.01	0.005	<0.01
2-Hexanone	8/10	0.01	0.01	0.01	0.009	0.01
4-Methyl-2-Pentanone	1/10	0.01	0.01	0.01	0.005	<0.01
Acetone	8/10	0.01	0.01	0.01	0.009	0.01
Benzene	3/10	0.005	0.001-0.006	0.006	0.003	<0.005
Bromodichloromethane	1/10	0.005	0.005	0.005	0.003	<0.005
Bromoform	1/10	0.005	0.005	0.005	0.003	<0.005
Bromomethane	1/10	0.01	0.01	0.01	0.005	<0.01
Carbon disulfide	1/10	0.005	0.005	0.005	0.003	<0.005
Carbon Tetrachloride	1/10	0.005	0.005	0.005	0.003	<0.005
Chlorobenzene	1/10	0.005	0.005-0.011	0.011	0.003	<0.005
Chloroethane	1/10	0.01	0.01	0.01	0.005	<0.01
Chloroform	1/10	0.005	0.005	0.005	0.003	<0.005
Chloromethane	1/10	0.01	0.01	0.01	0.005	<0.01
Dibromochloromethane	1/10	0.005	0.005	0.005	0.003	<0.005
Ethylbenzene	4/10	0.005	0.002-0.012	0.012	0.003	<0.005
Methylene chloride	1/10	0.005	0.005	0.009	0.003	<0.005
Styrene	1/10	0.005	0.005	0.005	0.003	<0.005
Tetrachloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
Toluene	3/10	0.005	0.001-0.005	0.005	0.002	<0.005
Trichloroethane	1/10	0.005	0.005	0.005	0.003	<0.005
Vinyl acetate	1/10	0.01	0.01	0.01	0.005	<0.01
Vinyl chloride	1/10	0.01	0.01	0.01	0.005	<0.01
Xylenes	5/10	0.005	0.002-0.160	0.16	0.008	<0.005

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)

b. On site background values are from monitoring well #23

NA not applicable

TABLE 2-3 (cont.)
SUMMARY OF MONITORING WELL DATA
AT MCALLISTER POINT LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/L)	RANGE OF DETECTION (mg/L)	MAXIMUM CONCENTRATION (mg/L)	GEOMETRIC MEAN OF ON SITE CONCENTRATIONS (mg/L)	ON SITE BACKGROUND CONCENTRATIONS (mg/L) ^b
SEMI-VOLATILES						
1,2-Dichlorobenzene	1/10	0.01	0.01	0.01	0.005	<0.01
1,2,4-Trichlorobenzene	1/10	0.01	0.01	0.01	0.005	<0.01
1,3-Dichlorobenzene	2/10	0.01	0.008-0.01	0.01	0.005	<0.01
1,4-Dichlorobenzene	1/10	0.01	0.01	0.01	0.005	<0.01
2-Chloronaphthalene	1/10	0.01	0.01	0.01	0.005	<0.01
2-Chlorophenol	0/10	0.01	NA	NA	0.005	<0.01
2-Methylnaphthalene	4/10	0.01	0.001-0.043	0.043	0.007	<0.01
2-Methylphenol	0/10	0.01	NA	NA	0.005	<0.01
2-Nitroaniline	1/10	0.05	0.05	0.05	0.027	<0.05
2-Nitrophenol	0/10	0.01	NA	NA	0.005	<0.01
2,4-Dichlorophenol	0/10	0.01	NA	NA	0.005	<0.01
2,4-Dimethylphenol	3/10	0.01	0.001-0.007	0.007	0.004	<0.01
2,4-Dinitrophenol	0/10	0.05	NA	NA	0.025	<0.05
2,4-Dinitrotoluene	1/10	0.01	0.01	0.01	0.005	<0.01
2,4,5-Trichlorophenol	0/10	0.05	NA	NA	0.025	<0.05
2,4,6-Trichlorophenol	0/10	0.01	NA	NA	0.005	<0.01
2,6-Dinitrotoluene	1/10	0.01	0.01	0.01	0.005	<0.01
3-Nitroaniline	1/10	0.05	0.05	0.05	0.027	<0.05
3,3'-Dichlorobenzidine	1/10	0.02	0.02	0.02	0.011	<0.02
4-Bromophenyl-phenylether	1/10	0.01	0.01	0.01	0.005	<0.01
4-Chloro-3-methylphenol	2/10	0.01	0.002-0.004	0.004	0.004	<0.01
4-Chloroaniline	1/10	0.01	0.01	0.01	0.005	<0.01
4-Chlorophenyl-phenylether	1/10	0.01	0.01	0.01	0.005	<0.01
4-Methylphenol	1/10	0.01	0.005	0.005	0.005	<0.01
4-Nitroaniline	1/10	0.05	0.05	0.05	0.027	<0.05
4-Nitrophenol	0/10	0.05	NA	NA	0.025	<0.05
4,6-dinitro-2-methylphenol	0/10	0.05	NA	NA	0.025	<0.05
Acenaphthene	3/10	0.01	0.003-0.045	0.045	0.008	<0.01
Acenaphthylene	1/10	0.01	0.01	0.01	0.005	<0.01
Anthracene	2/10	0.01	0.003-0.01	0.01	0.005	<0.01
Benzoic acid	1/10	0.05	0.007	0.007	0.021	<0.05
Benzo(a)anthracene	1/10	0.01	0.01	0.01	0.005	<0.01
Benzo(a)pyrene	1/10	0.01	0.01	0.01	0.005	<0.01
Benzo(b)fluoranthene	1/10	0.01	0.01	0.01	0.005	<0.01
Benzo(g,h,i)perylene	1/10	0.01	0.01	0.01	0.005	<0.01
Benzo(k)fluoranthene	1/10	0.01	0.01	0.01	0.005	<0.01
Benzyl Alcohol	1/10	0.01	0.01	0.01	0.005	<0.01
Bis(2-chloroethoxy)methane	1/10	0.01	0.01	0.01	0.005	<0.01
Bis(2-chloroethyl)ether	1/10	0.01	0.01	0.01	0.005	<0.01
Bis(2-chloroisopropyl)ether	1/10	0.01	0.01	0.01	0.005	<0.01
Bis(2-ethylhexyl)phthalate	1/10	0.01	0.01	0.01	0.005	<0.01
Butylbenzylphthalate	1/10	0.01	0.01	0.01	0.005	<0.01
Chrysene	1/10	0.01	0.01	0.01	0.005	<0.01
Dibenzofuran	2/10	0.01	0.01-0.019	0.019	0.008	<0.01
Dibenz(a,h)anthracene	1/10	0.01	0.01	0.01	0.005	<0.01
Diethylphthalate	5/10	0.01	0.001-0.01	0.01	0.004	<0.01
Dimethylphthalate	1/10	0.01	0.01	0.01	0.005	<0.01
Di-n-butylphthalate	1/10	0.01	0.01	0.01	0.005	<0.01
Di-n-octylphthalate	1/10	0.01	0.01	0.01	0.005	<0.01
Fluoranthene	2/10	0.01	0.002-0.01	0.01	0.005	<0.01
Fluorene	3/10	0.01	0.003-0.025	0.025	0.008	<0.01
Hexachlorobenzene	1/10	0.01	0.01	0.01	0.005	<0.01
Hexachlorobutadiene	1/10	0.01	0.01	0.01	0.005	<0.01
Hexachlorocyclopentadiene	2/10	0.01	0.01	0.01	0.008	<0.01
Hexachloroethane	1/10	0.01	0.01	0.01	0.005	<0.01
Indeno(1,2,3-cd)pyrene	1/10	0.01	0.01	0.01	0.005	<0.01
Isophthalene	1/10	0.01	0.01	0.01	0.005	<0.01
Naphthalene	4/10	0.01	0.003-0.24	0.24	0.008	<0.01
Nitrobenzene	1/10	0.01	0.01	0.01	0.005	<0.01
N-nitroso-di-n-propylamine	1/10	0.01	0.01	0.01	0.005	<0.01
N-nitrosodiphenylamine	1/10	0.01	0.01	0.01	0.005	<0.01
Pentachlorophenol	0/10	0.05	NA	0	0.025	<0.05
Phenanthrene	3/10	0.01	0.003-0.021	0.021	0.008	<0.01
Phenol	0/10	0.01	NA	0	0.005	<0.01
Pyrene	2/10	0.01	0.001-0.01	0.01	0.005	<0.01
PESTICIDES						
4,4'-DDD	0/2	0.1	NA	NA	NA	NA
4,4'-DDE	0/2	0.1	NA	NA	NA	NA
4,4'-DDT	0/2	0.1	NA	NA	NA	NA
Aldrin	0/2	0.05	NA	NA	NA	NA
Alpha-BHC	0/2	0.05	NA	NA	NA	NA
Alpha-chlordane	0/2	0.5	NA	NA	NA	NA
Beta-BHC	0/2	0.05	NA	NA	NA	NA
Delidrin	0/2	0.1	NA	NA	NA	NA
Delta-BHC	0/2	0.05	NA	NA	NA	NA
Endosulfan I	0/2	0.05	NA	NA	NA	NA
Endosulfan II	0/2	0.1	NA	NA	NA	NA
Endosulfan Sulfate	0/2	0.1	NA	NA	NA	NA
Endrin	0/2	0.1	NA	NA	NA	NA
Endrin ketone	0/2	0.1	NA	NA	NA	NA
Gamma-BHC	0/2	0.05	NA	NA	NA	NA
Gamma-chlordane	0/2	0.5	NA	NA	NA	NA
Heptachlor	0/2	0.05	NA	NA	NA	NA
Heptachlor epoxide	0/2	0.05	NA	NA	NA	NA
Methoxychlor	0/2	0.5	NA	NA	NA	NA
Toxaphene	0/2	1	NA	NA	NA	NA
PCB's						
Proclor-1018	0/2	0.5	NA	NA	NA	NA
Proclor-1221	0/2	0.5	NA	NA	NA	NA
Proclor-1232	0/2	0.5	NA	NA	NA	NA
Proclor-1242	0/2	0.5	NA	NA	NA	NA
Proclor-1248	0/2	0.5	NA	NA	NA	NA
Proclor-1254	0/2	1	NA	NA	NA	NA
Proclor-1260	0/2	1	NA	NA	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQL)

b. On site background values are from monitoring well #23

NA not applicable

TABLE 2-4
SUMMARY OF CONTAMINANTS
MCALLISTER POINT LANDFILL

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (mg/L)
INORGANICS			
Aluminum	4215-18900	2710-28100	0.412-284
Antimony	4.0-91.4	3.5-167	0.022-0.259
Arsenic	1.9-20	2-22.9	0.021-0.0894
Barium	12-128	7.9-214	0.006-1.77
Beryllium	0.16-1.7	0.33-2	0.002-0.0128
Cadmium	0.8-2	0.57-8.8	0.003-0.0571
Calcium	568-45800	306-14000	8.030-1.38
Chromium	5.2-59.2	4.7-78.1	0.0189-0.248
Cobalt	3.6-20.2	1.5-28	0.0223-0.737
Copper	13.4-6070	11-1780	0.0573-3.16
Cyanide	0.61-0.67	0.63-0.81	0.010
Iron	5510-78000	5840-50000	0.702-537
Lead	7.3-1980	2.1-888	0.003-4.8
Magnesium	311-5800	809-7840	4.88-89.2
Manganese	217-678	45.5-1300	0.0578-21
Mercury	0.14-1.6	0.11-2.9	0.00032-0.0084
Nickel	3.4-105	2.7-88.3	0.0167-0.678
Potassium	148-912	137-912	1.6-31.7
Selenium	0.35-2	0.33-4.2	0.0025
Silver	0.44-32.3	0.49-18.1	0.0268-0.128
Sodium	425-468	17.3-677	9.75-238
Thallium	X 0.775-1.2	ND	0.004-0.04
Vanadium	11-289	6.8-221	0.109
Zinc	38.1-19200	18.3-2060	0.168-12.1
VOLATILES			
1,1-Dichloroethane	X 0.009	0.003-0.006	X 0.005
1,1-Dichloroethene	&*	X 0.009	X 0.005
1,1,1-Trichloroethane	&*	0.0035-0.009	0.003-0.010
1,1,2-Trichloroethane	&*	X 0.008-0.009	X 0.006
1,1,2,2-Tetrachloroethane	&	X 0.006-0.012	X 0.006
1,2-Dichloroethane	&	X 0.009	X 0.006
1,2-Dichloroethene	&*	X 0.009	0.006-0.34
1,2-Dichloropropane	&	X 0.008-0.009	X 0.006
1,3-Dichloropropane (Cis)		X 0.008-0.009	X 0.006
1,3-Dichloropropane (Trans)		X 0.008-0.009	X 0.006
2-Butanone		ND	0.011-0.023
2-Hexanone	&	X 0.014-0.025	0.011-0.023
4-Methyl-2-Pentanone		X 0.014-0.025	0.011-0.013
Acetone		0.002-0.025	X 0.011-0.012
Benzene	&*	X 0.008-0.009	0.004-0.006
Bromodichloromethane	&*	X 0.008-0.009	X 0.006
Bromofom	&*	X 0.008-0.009	X 0.005-0.012
Bromomethane		0.017	X 0.012-0.013
Carbon disulfide		0.009	0.001-0.008
Carbon Tetrachloride	&*	X 0.008-0.009	X 0.006
Chlorobenzene	&*	0.002-0.012	0.001-0.032
Chloroethane		0.017	X 0.012-0.013
Chloroform	&*	X 0.009	0.003-0.006
Chloromethane	&*	X 0.01-0.017	X 0.012-1.7
Dibromochloromethane	&*	X 0.008-0.009	X 0.006-0.012
Ethylbenzene	&*	X 0.008-0.012	0.002-0.38
Methylene chloride		0.009	ND
Styrene	&*	X 0.008-0.012	X 0.006
Tetrachloroethene	&***	0.002-0.012	0.002-0.38
Toluene	&*	0.002-0.012	0.001-0.88
Trichloroethene	&	X 0.008-0.009	0.001-0.240
Vinyl acetate		X 0.015-0.017	X 0.011-0.013
Vinyl chloride	&	X 0.015-0.017	X 0.012-0.013
Xylenes	&*	X 0.008-0.012	0.003-0.73

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "UJ" qualified data only

ND Not Detected

TABLE 2-4 (cont.)
SUMMARY OF CONTAMINANTS
MCALLISTER POINT LANDFILL

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (mg/L)
SEMIVOLATILES			
1,2-Dichlorobenzene	X 44	X 0.39-2.7	X 0.01
1,2,4-Trichlorobenzene	X 44	X 0.39-2.7	X 0.01
1,3-Dichlorobenzene	X 44	X 0.39-2.7	X 0.008-0.01
1,4-Dichlorobenzene	&** X 44	X 0.05-2.2	0.01
2-Chloronaphthalene	X 44	X 0.39-2.7	X 0.01
2-Chlorophenol	X 44	X 0.39-2.7	ND
2-Methylnaphthalene	&* 0.099-1.1	X 0.05-4.6	0.001-0.043
2-Methylphenol	X 44	X 0.39-2.7	ND
2-Nitroaniline	X 2.2	X 1.95-14.0	X 0.05
2-Nitrophenol	X 44	X 0.39-2.7	ND
2,4-Dichlorophenol	&*** X 44	X 0.054-2.7	ND
2,4-Dimethylphenol	X 44	X 0.39-2.7	0.001-0.007
2,4-Dinitrophenol	X 2.2	X 1.95-14.0	ND
2,4-Dinitrotoluene	X 44	X 0.39-2.7	0.01
2,4,6-Trichlorophenol	&** X 2.2	X 0.11-14.0	ND
2,4,6-Trichlorophenol	X 44	X 0.39-2.7	ND
2,6-Dinitrotoluene	X 44	X 0.39-2.7	X 0.01
3-Nitroaniline	X 2.2	X 1.95-14.0	X 0.05
3,3-Dichlorobenzidine	& X 0.67-16.0	X 0.786-6.4	X 0.02
4-Bromophenyl-phenylether	X 44	X 0.39-2.7	X 0.01
4-Chloro-3-methylphenol	X 44	X 0.39-2.7	X 0.002-0.004
4-Chloroaniline	X 44	X 0.39-2.7	X 0.01
4-Chlorophenyl-phenylether	X 44	X 0.39-2.7	X 0.01
4-Methylphenol	X 44	X 0.069-5.8	X 0.005
4-Nitroaniline	X 44	X 1.95-14.0	X 0.05
4-Nitrophenol	X 2.2	X 1.95-14.0	ND
4,6-dinitro-2-methylphenol	X 2.2	X 1.95-14.0	ND
Acenaphthene	&**** 0.11-3.8	X 0.057-5.8	0.003-0.046
Acenaphthylene	&**** 0.44-0.052	X 0.068-2.7	X 0.01
Anthracene	&**** 0.044-6.8	X 0.057-2.7	0.003-0.01
Benzoic acid	0.38-2.2	0.84-14.0	0.007
Benzo(a)anthracene	&**** 0.052-18.0	X 0.044-3.7	X 0.01
Benzo(a)pyrene	&**** 0.44-16.0	X 0.073-3.2	X 0.01
Benzo(b)fluoranthene	&**** 0.12-15.0	X 0.05-2.7	X 0.01
Benzo(ghi)perylene	&**** 0.2-8.4	X 0.057-2.7	X 0.01
Benzo(k)fluoranthene	&**** 0.119-14.0	X 0.052-2.9	X 0.01
Benzyl Alcohol	X 0.44	X 0.39-2.7	X 0.01
Bis(2-chloroethoxy)methane	X 0.44	X 0.39-2.7	X 0.01
Bis(2-chloroethyl)ether	X 0.44	X 0.39-2.7	X 0.01
Bis(2-chloroisopropyl)ether	X 0.44	X 0.39-2.7	X 0.01
Bis(2-ethylhexyl)phthalate	&* 0.44-7.9	X 0.11-12.0	X 0.01
Butylbenzylphthalate	&* 0.44-7.9	X 0.31-2.7	X 0.01
Chrysene	&**** 0.072-18.0	X 0.05-3.6	X 0.01
Dibenzofuran	&**** 0.05-2.8	X 0.043-4.0	0.01-0.019
Dibenzo(a,h)anthracene	&**** 0.074-7.9	X 0.3-2.7	X 0.01
Diethylphthalate	&* 0.275	X 0.045-2.7	0.001-0.01
Dimethylphthalate	&* X 0.44	X 0.39-2.7	X 0.01
Di-n-butylphthalate	&* 0.44	X 0.046-6.7	X 0.01
Di-n-octylphthalate	&* X 0.37-7.9	X 0.096-2.7	X 0.01
Fluoranthene	&**** 0.17-46.0	X 0.047-5.9	0.002-0.01
Fluorene	&**** 0.09-4.7	X 0.044-4.4	0.003-0.025
Hexachlorobenzene	X 0.44	X 0.39-2.7	X 0.01
Hexachlorobutadiene	X 0.44	X 0.39-2.7	X 0.01
Hexachlorocyclopentadiene	X 0.44	X 0.39-2.7	X 0.01
Hexachloroethane	X 0.44	X 0.39-2.7	X 0.01
Indeno(1,2,3cd)pyrene	&**** 0.16-8.9	X 0.21-2.7	X 0.01
Isophorone	X 44	X 0.39-2.7	X 0.01
Naphthalene	&**** 0.044-3.0	X 0.047-3.0	0.003-0.024
Nitrobenzene	X 0.44	X 0.39-2.7	X 0.01
N-nitroso-di-n-propylamine	X 0.44	X 0.39-2.7	X 0.01
N-nitrosodiphenylamine	X 0.44	X 0.39-2.7	X 0.01
Pentachlorophenol	X 2.2	X 1.95-14.0	ND
Phenanthrene	&**** 0.080-26.0	X 0.08-6.2	0.003-0.021
Phenol	&** X 0.44	X 0.15-2.7	ND
Pyrene	&**** 0.098-27.0	X 0.045-4.4	0.001-0.01
PESTICIDES			
4,4'-DDD	&* 0.019-0.19	X 0.0033-0.2	ND
4,4'-DDE	&* 0.0107-0.024	X 0.0023-0.2	ND
4,4'-DDT	&* 0.007-1.8	X 0.0044-0.3	ND
Aldrin	&* X 0.0095	X 0.0085-0.1	ND
Alpha-BHC	&* X 0.0095	X 0.0085-0.1	ND
Alpha-chlordane	&* X 0.095	X 0.0845-1.0	ND
Beta-BHC	&* X 0.0095	X 0.0085-0.1	ND
Deltrin	&* X 0.019	X 0.017-0.2	ND
Delta-BHC	&* X 0.0095	X 0.0085-0.1	ND
Endosulfan I	& X 0.0095	X 0.0085-0.1	ND
Endosulfan II	& X 0.019	X 0.017-0.2	ND
Endosulfan Sulfate	& X 0.019	X 0.017-0.2	ND
Endrin	& X 0.019	X 0.017-0.2	ND
Endrin ketone	& X 0.019	X 0.017-0.2	ND
Gamma-BHC	&* X 0.0095	X 0.0085-0.1	ND
Gamma-chlordane	&* X 0.095	X 0.0845-1.0	ND
Heptachlor	&* X 0.0095	X 0.0085-0.1	ND
Heptachlor epoxide	&* X 0.0095	X 0.0085-0.1	ND
Methoxychlor	& X 0.095	X 0.0845-1.0	ND
Toxaphene	&* X 19	X 0.067-2.0	ND
PCB's			
Aroclor-1016	&* X 0.095	X 0.0845-1.0	ND
Aroclor-1221	&* X 0.095	X 0.0845-1.0	ND
Aroclor-1232	&* X 0.095	X 0.0845-1.0	ND
Aroclor-1242	&* 0.095	X 0.044-1.0	ND
Aroclor-1248	&* X 0.095	X 0.0845-1.0	ND
Aroclor-1254	&* 0.13-0.81	X 0.025-2.0	ND
Aroclor-1260	&* X 0.19	X 0.17-2.0	ND

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "U" qualified data only

ND Not Detected

TABLE 2-6
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE – McALLISTER POINT LANDFILL

PARAMETER	VALUE OR RANGE	VALUE USED	RATIONALE	REFERENCE
Global variables				
Body Weight (kg)				
Children				
– scenario 1	36–61.2	49.2	Value based on average of males and females between 9–18 yrs	EPA 1990
– scenario 2		43.2	Value based on average of males and females between 6–18 yrs	EPA 1990
– scenario 5	11.6–17.4	14.5	Value based on average of males and females between 0–6 yrs	EPA 1989
Adult	67.2–74.5	70	Value based on average of males and females between 18–65 yrs	EPA 1989
Exposure Duration (years)				
– scenario 1	1–18	9	Based upon the age range of children likely to enter the site	
– scenario 2	1–18	12	Based upon the age range of children likely to use the site	
– scenario 3	1–70	1	Amount of time spent building an industrial facility	EPA 1991
– scenario 4	1–70	25	National upper-bound (90th percentile) at one job.	EPA 1991
– scenario 5				
Child	1–6	6	Number of years in this age group.	EPA 1991
Adult	1–70	30	National upper-bound (90th percentile) at one residence	EPA 1991
Averaging Time				
Cancer–risks (days)	NA	25,550	Value based upon 70 year life expectancy.	EPA 1989
Noncancer–risks (days)				
– scenario 1	350–25,550	3285	Value based upon exposure duration.	
– scenario 2	350–25,550	4380	Value based upon exposure duration.	
– scenario 3	0–365	365	Value based upon exposure duration.	
– scenario 4	250–25,550	9125	Value based upon exposure duration	
– scenario 5				
Child	350–2,190	2190	Value based upon exposure duration.	
Adult	350–25,550	10,950	Value based upon exposure duration.	
Soil Contact Rate (mg/day)	500–1000	500	Soil deposition=0.5mg/m ³ , skin surface area=2000cm ² , fraction exposed=50%	EPA 1989a
Absorption Factor				
– Dermal				
VOC's	0–1	0.5		EPA 1989a
PAHs/PCBs	0–1	0.05		EPA 1989a
Inorganics	0–1	negligible		EPA 1989a
Pesticides	0–1	0.05, 0.5	High; Low soil sorption, respectively	EPA 1989a
– Ingestion:				
VOC's, PAHs	0–1	1		EPA 1989a
Inorganics	0–1	1		EPA 1989a
Pesticides	0–1	0.3, 1	High; Low soil sorption, respectively	EPA 1989a
Lead	0–1	0.5, 0.3	Children, Adults, respectively	EPA 1989a
– Inhalation:	0–1	1	Complete absorption assumed	EPA 1989a
Permeability Constant – Dermal contact in Water (cm/hr)		8.4E–04	Based upon the penetration rate of water	EPA 1989
Chemical Concentration Justification				EPA 1989a
Surface Soils, Subsurface soils; Ground Water			Geometric mean and maximum values used in exposure estimates were calculated using the methods described in text	

TABLE 2-6
(continued)
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - McALLISTER POINT LANDFILL

Scenario 1 - Trespassing Exposure Current Use				
Exposure Frequency(days/year)	1-365	21	Based upon trespassing on an frequent basis.	
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-200	100	Soil ingestion rate for those over 6 years of age.	EPA 1991
Scenario 2 - Recreational Exposure Future Use				
Exposure Frequency(days/year)	1-365	104	Based on an estimate of the number of days using the ballfield	EPA 1991
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-200	100	Soil ingestion rate for those over 6 years of age.	EPA 1991
Scenario 3 - Construction Exposure Future Use				
Exposure Frequency(days/year)	1-365	250	Based on an estimate of the number of workdays in one year.	EPA 1991
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-480	480	Soil ingestion rate for construction work.	EPA 1991
Inhalation Of Airborne Chemicals Absorbed to Dust				
Inhalation Rate (m3/day)		14.4	Adults during moderate exertion (1.8 m3/hr, 8 hr/day)	EPA 1991
Scenario 4 - Industrial Exposure: Future Use				
Exposure Frequency (days/year)	1-365	250	Based on an estimate of the number of workdays in one year.	EPA 1991
Ingestion Of Chemicals In Drinking Water				
Ingestion Rate (L/day)		1	Water ingestion rate for a commercial setting	EPA 1991
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-480	50	Soil ingestion rate for a commercial setting.	EPA 1991
Scenario 5 - Residential Scenario Future Use				
Exposure Frequency (days/yr)	1-365	350	Two weeks spent away from home	EPA 1991
Ingestion Of Chemicals In Soils and House Dust				
Ingestion Rate (mg/day)				
Child	0-200	200	Children, 1-6 years old	EPA 1991
Adult	0-100	100	Age groups greater than 6 years old	EPA 1991
Ingestion Of Chemicals In Drinking Water				
Ingestion Rate (L/day)				
Child		0.750	Children, 0-6 years old	EPA 1990
Adult		2	Adult, 90th percentile	EPA 1989
Inhalation Of Airborne (Vapor Phase) Chemicals				
Inhalation Rate (m3/hr)		0.62	Adults and children, light activity assumed.	EPA 1991
Exposure Time (hrs/day)	0-24	0.2 hr	Based upon the duration of a shower.	EPA 1989
Inhalation Of Airborne Chemicals Absorbed to Dust				
Inhalation Rate (m3/day)		20	Adults and children, light activity assumed.	EPA 1991

TABLE 2-6
SCENARIO 1
SUMMARY OF CANCER RISK ESTIMATES
MCALLISTER POINT LANDFILL

CHEMICAL	TOTAL PATHWAY RISK	TOTAL RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	7.3E-08	1.8E-05	MAXIMUM
	3.2E-08	1.2E-06	MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	1.8E-05	MAXIMUM	
	1.1E-06	MEAN	

TABLE 2-7
SCENARIO 1
SUMMARY OF HAZARD INDEX
MCALLISTER POINT LANDFILL

CHEMICAL	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	3.9E-04 1.7E-04	6.0E-02 4.0E-03	MAXIMUM MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	6.4E-02 4.2E-03	MAXIMUM MEAN	

TABLE 2-8
SCENARIO 2
SUMMARY OF CANCER RISK ESTIMATES
MCALLISTER POINT LANDFILL

CHEMICAL	TOTAL PATHWAY RISK	TOTAL RISK	
	5.5E-07	1.3E-04	MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	2.4E-07	8.7E-06	MEAN
	1.3E-04		MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	8.4E-06		MEAN

TABLE 2-9
SCENARIO 2
SUMMARY OF HAZARD INDEX RATIOS
MCALLISTER POINT LANDFILL

CHEMICAL	PATHWAY	TOTAL	
	HAZARD	HAZARD	
	INDEX	INDEX	
	2.2E-03	3.6E-01	MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	9.8E-04	2.5E-02	MEAN
	3.6E-01	MAXIMUM	
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.4E-02	MEAN	

TABLE 2-10
SCENARIO 3
SUMMARY OF CANCER RISK ESTIMATES
MCALLISTER POINT LANDFILL

CHEMICAL	TOTAL PATHWAY RISK	TOTAL RISK	
	1.2E-06	2.3E-05	MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.6E-07	3.7E-06	MEAN
	2.2E-05		MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	3.7E-06		MEAN
	1.1E-09		MAXIMUM
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	1.7E-10		MEAN

TABLE 2-12
SCENARIO 4
SUMMARY OF CANCER RISK ESTIMATES
MCALLISTER POINT LANDFILL

CHEMICAL	CDI MEAN (mg/kg/day)	CDI MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK-MEAN	CHEMICAL SPECIFIC RISK-MAX	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL											1 7E-06 3 9E-03 MAXIMUM 7 4E-07 1 8E-03 MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL											2 1E-04 MAXIMUM 1 3E-05 MEAN
SEMIVOLATILES											
Benzo(a)anthracene	1 2E-07	3 3E-06	No	1 15E+01	B2	Liver, Lung, Skin	RIS	1 4E-06	3 8E-05		
Benzo(a)pyrene	1 5E-07	2 6E-06	No	1 15E+01	B2	Lung, Stomach	RIS	1 7E-06	3 2E-05		
Benzo(b)fluoranthene	1 6E-07	2 6E-06	No	1 15E+01	B2	Lung, Thorax, Skin	RIS	1 9E-06	3 0E-05		
Benzo(k)fluoranthene	1 5E-07	2 4E-06	No	1 15E+01	B2	Lung, Thorax, Skin	RIS	1 7E-06	2 8E-05		
Chrysene	1 4E-07	3 1E-06	No	1 15E+01	B2	Malignant lymphoma	RIS	1 7E-06	3 6E-05		
Indeno(123cd)pyrene	1 3E-07	1 6E-06	No	1 15E+01	B2	Lung, Skin	RIS	1 4E-06	1 8E-05		
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER											3 7E-03 MAXIMUM 1 8E-03 MEAN
INORGANICS											
Arsenic	1 0E-04	3 1E-04	No	1 75E+00	A	Skin	Water/RIS	1 7E-04	5 5E-04		
Beryllium	7 8E-06	4 5E-05	No	4 30E+00	B2	Gross tumors, all sites combined	Water/RIS	3 4E-05	1 9E-04		
SEMIVOLATILES											
Benzo(a)anthracene	1 9E-05	3 5E-05	No	1 15E+01	B2	Liver, Lung, Skin	RIS	2 2E-04	4 0E-04		
Benzo(a)pyrene	1 9E-05	3 5E-05	No	1 15E+01	B2	Lung, Stomach	RIS	2 2E-04	4 0E-04		
Benzo(b)fluoranthene	1 9E-05	3 5E-05	No	1 15E+01	B2	Lung, Thorax, Skin	RIS	2 2E-04	4 0E-04		
Benzo(k)fluoranthene	1 9E-05	3 5E-05	No	1 15E+01	B2	Lung, Thorax, Skin	RIS	2 2E-04	4 0E-04		
Chrysene	1 9E-05	3 5E-05	No	1 15E+01	B2	Malignant lymphoma	RIS	2 2E-04	4 0E-04		
Indeno(123cd)pyrene	1 9E-05	3 5E-05	No	1 15E+01	B2	Lung, Skin	RIS	2 2E-04	4 0E-04		

TABLE 2-13
SCENARIO 4
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
MCALLISTER POINT LANDFILL

CHEMICAL	CDI MEAN (mg/kg/day)	CDI MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT MEAN	HAZARD QUOTIENT MAX	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL												3.2E-03	1.3E+01
												1.4E-03	1.8E+00
												2.7E-01	MAXIMUM
												1.6E-02	MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL													
INORGANICS													
Antimony	3.3E-06	4.5E-05	No	4E-04	Low	Longevity, blood glucose and cholesterol	Water/IRIS, HEAST	1000	1	8.4E-03	1.1E-01		
												1.3E+01	MAXIMUM
												1.8E+00	MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER													
INORGANICS													
Antimony	3.6E-04	2.5E-03	No	4E-04	Low	Longevity, blood glucose and cholesterol	Water/IRIS, HEAST	1000	1	9.0E-01	8.3E+00		
Arsenic	2.8E-04	8.7E-04	No	1E-03		Keratosis and hyperpigmentation	Diet/HEAST	1		2.8E-01	8.7E-01		
Cadmium	5.0E-05	5.6E-04	No	1E-03	High	Proteinuria	Diet/IRIS, HEAST	10	1	5.0E-02	5.6E-01		
Chromium	3.0E-04	2.4E-03	No	5E-03	Low	No effects observed	Water/IRIS, HEAST	500	1	6.0E-02	4.9E-01		
Copper			No	4E-02		Local GI irritation	HEAST			3.5E-02	7.7E-01		
Lead	0.0E+00	0.0E+00	No	NA		Neurobehavioral effects	NA/IRIS, HEAST						
Manganese			No	1E-01	Medium	CNS effects	Diet/IRIS, HEAST	1	1	3.1E-01	2.1E+00		
Mercury			No	3E-04		Kidney effects	Oral/HEAST	1000		1.2E-02	2.7E-01		
Zinc	5.5E-03	1.2E-01	No	2E-01		Anemia	Therapeutic/HEAST	10		2.8E-02	5.9E-01		
SEMIVOLATILES													
Naphthalene	6.2E-05	2.3E-03	No	4E-03		Decreased body weight gain	Cavage/HEAST	10000		2.0E-02	5.9E-01		

TABLE 2-14
SCENARIO 5
SUMMARY OF CANCER RISK ESTIMATES
MCALLISTER POINT LANDFILL

COMPOUND NAME	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX (mg/kg/day)	CDI ADULT MAX (mg/kg/day)	CDI ADJ FOR ABS	SF (mg/kg/day) -1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEM SPEC RISK CHILD-MEAN	CHEM SPEC RISK ADULT-MEAN	CHEM SPEC RISK CHILD-MAX	CHEM SPEC RISK ADULT-MAX	TOTAL PATHWAY RISK	TOTAL RISK		
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER															2.2E-03	2.3E-03	CHILD MEAN
INORGANICS															6.0E-03	6.0E-03	ADULT MEAN
Arsenic	1.2E-04	3.4E-04	3.6E-04	1.0E-03	No	1.75E+00	A	Skin	Water/IRIS	2.1E-04	5.9E-04	6.7E-04	1.8E-03	4.5E-03	5.6E-03	CHILD MAX	
Beryllium	9.5E-06	2.6E-05	5.4E-05	1.5E-04	No	4.30E+00	B2	Gross tumors, all sites combined	Water/IRIS	4.1E-05	1.1E-04	2.3E-04	6.9E-04	1.2E-02	1.3E-02	ADULT MAX	
VOLATILES																	
Vinyl chloride	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.90E+00	A	Lung	Diet/HEAST	4.3E-05	1.2E-04	8.1E-05	2.2E-04				
1,1-Dichloroethene	1.1E-05	3.1E-05	2.1E-05	5.9E-05	No	6E-01	C	Adrenal pheochromocytomas	Oral/IRIS	6.6E-06	1.9E-05	1.3E-05	3.9E-05				
SEMIVOLATILES																	
3,3-Dichlorobenzidine	4.6E-05	1.3E-04	8.5E-05	2.3E-04	No	4.50E-01	B2	Mammary adenocarcinomas	Water/IRIS	2.1E-05	5.7E-05	3.8E-05	1.1E-04				
Benzo(a)anthracene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Liver, Lung, Skin	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
Benzo(a)pyrene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, Stomach	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
Benzo(b)fluoranthene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, Thorax, Skin	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
Benzo(k)fluoranthene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, Thorax, Skin	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
Chrysene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Malignant lymphoma	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
Indeno(123cd)pyrene	2.3E-05	6.3E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, Skin	IRIS	2.6E-04	7.2E-04	4.9E-04	1.4E-03				
															1.2E-06		CHILD MEAN
															1.2E-06		ADULT MEAN
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL															2.7E-06		CHILD MAX
															2.6E-06		ADULT MAX
															8.5E-05		CHILD MEAN
															4.4E-05		ADULT MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST															1.3E-03		CHILD MAX
															7.0E-04		ADULT MAX
SEMIVOLATILES																	
Benzo(a)anthracene	7.9E-07	4.1E-07	2.2E-05	1.1E-05	No	1.15E+01	B2	Liver, Lung, Skin	IRIS	9.1E-06	4.7E-06	2.5E-04	1.3E-04				
Benzo(a)pyrene	9.5E-07	4.9E-07	1.8E-05	9.4E-06	No	1.15E+01	B2	Lung, Stomach	IRIS	1.1E-05	5.6E-06	2.1E-04	1.1E-04				
Benzo(b)fluoranthene	1.1E-06	5.5E-07	1.7E-05	8.6E-06	No	1.15E+01	B2	Lung, Thorax, Skin	IRIS	1.2E-05	6.4E-06	2.0E-04	1.0E-04				
Chrysene	9.3E-07	4.8E-07	2.0E-05	1.1E-05	No	1.15E+01	B2	Malignant lymphoma	IRIS	1.1E-05	5.5E-06	2.3E-04	1.3E-04				
Benzo(k)fluoranthene	9.5E-07	4.9E-07	1.6E-05	8.2E-06	No	1.15E+01	B2	Lung, Thorax, Skin	IRIS	1.1E-05	5.7E-06	1.8E-04	9.9E-05				
Indeno(123cd)pyrene	8.1E-07	4.2E-07	1.0E-05	5.2E-06	No	1.15E+01	B2	Lung, Skin	IRIS	9.3E-06	4.6E-06	1.2E-04	6.0E-05				
															9.3E-06		CHILD MEAN
															9.0E-06		ADULT MEAN
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS															1.0E-05		CHILD MAX
															1.6E-05		ADULT MAX
															2.5E-06		CHILD MEAN
															2.6E-06		ADULT MEAN
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST															1.1E-07		CHILD MAX
															1.2E-07		ADULT MAX

COMPOUND NAME	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX (mg/kg/day)	CDI ADULT MAX (mg/kg/day)	ADJ FOR ABS	RFD (mg/kg/dy)	CONFID LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT CHILD MEAN	HAZARD QUOTIENT ADULT MEAN	HAZARD QUOTIENT CHILD MAX	HAZARD QUOTIENT ADULT MAX	PATHWAY HAZARD INDEX (H)	TOTAL HAZARD INDEX (HI)		
																	9 1E+00	9 1E+00	CHILD MEAN
																	5 0E+00	5 0E+00	ADULT MEAN
																	6 4E+01	6 5E+01	CHILD MAX
																	3 8E+01	3 8E+01	ADULT MAX
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER																			
INORGANICS																			
Arsimony	1 8E-03	1 0E-03	1 3E-02	7 1E-03	No	4E-04	Low	Longevity, blood glucose and cholesterol	Water/IRIS,HEAST	1000	1	4 6E+00	2 5E+00	3 2E+01	1 6E+01				
Arsenic	1 4E-03	7 6E-04	4 4E-03	2 4E-03	No	1E-03		Keratosis and hyperpigmentation	Diet/HEAST	1		1 4E+00	7 6E-01	4 4E+00	2 4E+00				
Cadmium	2 5E-04	1 4E-04	2 6E-03	1 6E-03	No	1E-03	High	Proteinuria	Diet/IRIS,HEAST	10	1	2 5E-01	1 4E-01	2 6E+00	1 6E+00				
Chromium	1 5E-03	6 3E-04	1 2E-02	6 6E-03	No	5E-03	Low	No effects observed	Water/IRIS,HEAST	500	1	3 0E-01	1 7E-01	2 5E+00	1 4E+00				
Copper	7 2E-03	4 0E-03	1 6E-01	8 7E-02	No	4E-02		Local GI irritation	HEAST			1 6E-01	9 9E-02	3 9E+00	2 2E+00				
Manganese	1 9E-01	6 6E-02	1 0E+00	5 6E-01	No	1E-01	Medium	CNS effects	Diet/IRIS,HEAST	1	1	1 6E+00	8 8E-01	1 0E+01	5 6E+00				
Mercury	1 6E-05	9 8E-06	4 2E-04	2 3E-04	No	3E-04		Kidney effects	Oral/HEAST	1000		5 9E-02	3 3E-02	1 4E+00	7 7E-01				
Zinc	2 8E-02	1 5E-02	6 0E-01	3 3E-01	No	2E-01		Anemia	Therapeutic/HEAST	10		1 4E-01	7 7E-02	3 0E+00	1 7E+00				
																	1 3E-02		CHILD MEAN
																	2 7E-03		ADULT MEAN
																	7 9E-02		CHILD MAX
																	1 6E-02		ADULT MAX
																	5 1E-01		CHILD MEAN
																	5 3E-02		ADULT MEAN
																	7 7E+00		CHILD MAX
																	8 0E-01		ADULT MAX
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																			
INORGANICS																			
Arsimony	9 0E-05	9 4E-06	1 2E-03	1 3E-04	No	4E-04	Low	Longevity, blood glucose and cholesterol	Water/IRIS,HEAST	1000	1	2 3E-01	2 3E-02	3 0E+00	3 1E-01				
Copper	1 1E-03	1 2E-04	6 0E-02	8 3E-03	No	4E-02		Local GI irritation	HEAST			2 6E-02	2 9E-03	2 0E+00	2 1E-01				
Zinc	3 2E-03	3 4E-04	2 5E-01	2 6E-02	No	2E-01		Anemia	Therapeutic/HEAST	10		1 6E-02	1 7E-03	1 3E+00	1 3E-01				
																	1 6E-02		CHILD MEAN
																	3 7E-03		ADULT MEAN
																	1 0E-01		CHILD MAX
																	2 1E-02		ADULT MAX
																	1 3E-03		CHILD MEAN
																	2 6E-04		ADULT MEAN
																	2 4E-03		CHILD MAX
																	5 1E-04		ADULT MAX
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																			
																	1 3E-03		CHILD MEAN
																	2 6E-04		ADULT MEAN
																	2 4E-03		CHILD MAX
																	5 1E-04		ADULT MAX
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																			

Table 2-16

Uptake/Biokinetic Model

Inputs and Outputs Using the Geometric Mean Soil Lead for the Entire Site

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.200 ug Pb/m³ DEFAULT
 Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m ³ /day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
 WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: Multiple Source Analysis

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	98.8	47.7
1-2	98.8	47.7
2-3	98.8	47.7
3-4	98.8	47.7
4-5	98.8	47.7
5-6	98.8	47.7
6-7	98.8	47.7

Additional Dust Sources: None DEFAULT

Soil contribution conversion factor: 0.28

Air contribution conversion factor: 100.0

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

Maternal Blood Conc: 7.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	2.79	7.62	4.24
1-2:	2.49	8.27	4.24
2-3:	2.48	8.80	4.24
3-4:	2.53	8.72	4.24
4-5:	2.60	8.65	4.24
5-6:	2.62	8.96	4.24
6-7:	2.67	9.35	4.24

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.94	0.40	0.00	0.04
1-2:	2.96	1.00	0.00	0.07
2-3:	3.40	1.04	0.00	0.12
3-4:	3.29	1.06	0.00	0.13
4-5:	3.18	1.10	0.00	0.13
5-6:	3.38	1.16	0.00	0.19
6-7:	3.74	1.18	0.00	0.19

Table 2-17
Uptake/Biokinetic Model

Inputs and Outputs Using the Geometric Mean Soil Lead for the "Impacted" Zone

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.200 ug Pb/m³ DEFAULT
Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m ³ /day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT
WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: Multiple Source Analysis

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	634.0	197.5
1-2	634.0	197.5
2-3	634.0	197.5
3-4	634.0	197.5
4-5	634.0	197.5
5-6	634.0	197.5
6-7	634.0	197.5

Additional Dust Sources: None DEFAULT
Soil contribution conversion factor: 0.28
Air contribution conversion factor: 100.0

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model
Maternal Blood Conc: 7.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)
0.5-1:	8.38	27.02	23.64
1-2:	8.21	27.66	23.64
2-3:	8.06	28.20	23.64
3-4:	8.15	28.11	23.64
4-5:	8.41	28.05	23.64
5-6:	8.42	28.36	23.64
6-7:	8.37	28.74	23.64

YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.94	0.40	0.00	0.04
1-2:	2.96	1.00	0.00	0.07
2-3:	3.40	1.04	0.00	0.12
3-4:	3.29	1.06	0.00	0.13
4-5:	3.18	1.10	0.00	0.13
5-6:	3.38	1.16	0.00	0.19
6-7:	3.74	1.18	0.00	0.19

Uptake/Biokinetic Model

Inputs and Outputs Using the Maximum Soil Lead for the Entire Site

ABSORPTION METHODOLOGY: Non-Linear Active-Passive

AIR CONCENTRATION: 0.200 ug Pb/m³ DEFAULT

Indoor AIR Pb Conc: 30.0 percent of outdoor.

Other AIR Parameters:

Age	Time Outdoors (hr)	Vent. Rate (m ³ /day)	Lung Abs. (%)
0-1	1.0	2.0	32.0
1-2	2.0	3.0	32.0
2-3	3.0	5.0	32.0
3-4	4.0	5.0	32.0
4-5	4.0	5.0	32.0
5-6	4.0	7.0	32.0
6-7	4.0	7.0	32.0

DIET: DEFAULT

DRINKING WATER Conc: 4.00 ug Pb/L DEFAULT

WATER Consumption: DEFAULT

SOIL & DUST:

Soil: constant conc.

Dust: Multiple Source Analysis

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
0-1	1980.0	574.4
1-2	1980.0	574.4
2-3	1980.0	574.4
3-4	1980.0	574.4
4-5	1980.0	574.4
5-6	1980.0	574.4
6-7	1980.0	574.4

Additional Dust Sources: None DEFAULT

Soil contribution conversion factor: 0.28

Air contribution conversion factor: 100.0

PAINT Intake: 0.00 ug Pb/day DEFAULT

MATERNAL CONTRIBUTION: Infant Model

Maternal Blood Conc: 7.50 ug Pb/dL

CALCULATED BLOOD Pb and Pb UPTAKES:

YEAR	Blood Level (ug/dL)	Total Uptake (ug/day)	Soil+Dust Uptake (ug/day)	
0.5-1:	22.44	75.80	72.42	
1-2:	22.67	76.44	72.42	
2-3:	22.19	76.97	72.42	
3-4:	22.40	76.89	72.42	
4-5:	23.16	76.83	72.42	
5-6:	23.12	77.14	72.42	
6-7:	22.87	77.52	72.42	
YEAR	Diet Uptake (ug/day)	Water Uptake (ug/day)	Paint Uptake (ug/day)	Air Uptake (ug/day)
0.5-1:	2.94	0.40	0.00	0.04
1-2:	2.96	1.00	0.00	0.07
2-3:	3.40	1.04	0.00	0.12
3-4:	3.29	1.06	0.00	0.13
4-5:	3.18	1.10	0.00	0.13
5-6:	3.38	1.16	0.00	0.19
6-7:	3.74	1.18	0.00	0.19

TABLE 2-19

Lead Uptake/Biokinetic Model Results for McAllister Point

Scenario	Soil Lead (ppm)	House Dust Lead (ppm)	Geometric Mean Blood Lead ($\mu\text{g}/\text{dl}$)	% Children $\geq 10 \mu\text{g}/\text{dl}$
Mean Soil Lead for Entire Site	99	48	2.74	0.01
Mean Soil Lead for "Impacted" Zone	634	198	8.22	27.37
Maximum Soil Lead for Entire Site	1,980	574	22.07	98.10

TABLE 2--20
SUMMARY OF EXPOSURE PATHWAYS
McALLISTER POINT LANDFILL

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Inclusion
Current Land Use			
Children	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Children	Ingestion of soils on site	Yes	Access to site unrestricted
Children	Ingestion of sediments on site	No	Soils data includes contamination near shore
Children	Ingestion of surface water on site	No	Data not available
Children	Dermal contact with soils	Yes	Access to site unrestricted
Children	Dermal contact with sediments	No	Soils data includes contamination near shore
Children	Inhalation of fugitive dusts	No	Site vegetated
Children	Dermal contact with surface water	No	Data not available
Future Land Use			
Recreational	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Recreational	Ingestion of soils on site	Yes	Access to site unrestricted
Recreational	Ingestion of sediments on site	No	Soils data includes contamination near shore
Recreational	Ingestion of surface water on site	No	Data not available
Recreational	Dermal contact with soils	Yes	Access to site unrestricted
Recreational	Dermal contact with sediments	No	Soils data includes contamination near shore
Recreational	Inhalation of fugitive dusts	No	Site vegetated
Recreational	Dermal contact with surface water	No	Data not available
Residents	Ingestion of ground water from local wells on the site	Yes	Potential residential use of site
Residents	Ingestion of soils on site	Yes	Potential residential use of site
Residents	Ingestion of sediments on site	No	Soils data includes contamination near shore
Residents	Ingestion of surface water on site	No	Contact route unlikely; ground water available for ingestion
Residents	Dermal contact with soils	Yes	Potential residential use of site
Residents	Dermal contact with sediments	No	Soils data includes contamination near shore
Residents	Inhalation of fugitive dusts	Yes	Potential residential use of site may produce areas devoid of cover
Residents	Inhalation of chemicals volatilized from ground water during home use	Yes	Potential residential use of site; volatile organics in ground water
Construction Workers	Ingestion of ground water from local wells	No	Wells not developed during construction
Construction Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Construction Workers	Ingestion of sediments on site	No	Soils data includes contamination near shore
Construction Workers	Ingestion of surface water on site	No	Contact route unlikely
Construction Workers	Dermal contact with soils	Yes	Contact with soils expected during construction
Construction Workers	Dermal contact with sediments	No	Contact route unlikely
Construction Workers	Inhalation of fugitive dusts	Yes	Generation of fugitive dust expected during construction
Industrial Employees	Ingestion of ground water from local wells	Yes	Potable supply from ground water
Industrial Employees	Ingestion of soils on site	Yes	Incidental ingestion expected
Industrial Employees	Ingestion of sediments on site	No	Soils data includes contamination near shore
Industrial Employees	Ingestion of surface water on site	No	Contact route unlikely
Industrial Employees	Dermal contact with soils	Yes	Contact with soils may occur during work hours
Industrial Employees	Dermal contact with sediments	No	Contact route unlikely
Industrial Employees	Inhalation of fugitive dusts	No	Generation of fugitive dust not expected (Site vegetated or paved)

TABLE 3-1
SUMMARY OF SURFACE SOIL DATA
OF MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg) ^b	RANGE OF U S BACKGROUND (mg/kg) ^b	ON SITE BACKGROUND LEVELS (mg/kg) ^d
INORGANICS								
Aluminum	20/20	(0.2)a	2900-12700	7414.12	12700	33000	7000-100000	11500
Arsimony	7/20	4.3-7.6	4.9-50.4	4.64	50.4	0.52	<1-8.8	4.9
Arsenic	20/20	(0.01)a	2.1-23.4	5.70	23.4	4.8	0.1-73	7.5
Barium	20/20	(0.2)a	6.5-269	18.47	269	290	10-1500	12.6
Beryllium	9/20	0.19-0.35	0.19-0.52	0.21	0.52	0.55	1-7	<0.22
Cadmium	4/20	0.48-4.2	0.6-1.2	0.57	3	0.28 c	NA	0.93
Calcium	20/20	(5.0)a	337-8720	954.54	8720	3400	100-280000	1160
Chromium	20/20	(0.01)a	5.1-35.2	12.63	35.2	33	1-1000	15.8
Cobalt	20/20	(0.05)a	3.2-16.7	8.11	16.7	5.9	0.3-70	14.0
Copper	20/20	(0.025)a	12.2-206	27.64	206	13	1-700	22.7
Cyanide	2/20	0.51-1.4	0.78-1.5	0.37	NA	NA	NA	<0.57
Iron	20/20	(0.1)a	7870-29100	15559.15	29100	14000	100-100000	28800
Lead	20/20	(0.005)a	10.2-400.5	48.26	400.5	14	10-300	10.2
Magnesium	20/20	(5.0)a	959-4530	1983.05	4530	2100	50-50000	3500
Manganese	20/20	(0.015)a	109-600	251.63	600	260	2-7000	294
Mercury	7/20	0.10-0.18	0.14-1.1	0.14	1.1	0.061	0.01-3.4	<0.11
Nickel	20/20	(0.04)a	6-32.2	14.72	32.2	11	5-700	21.3
Potassium	18/20	134-189	228-472	285.35	472	12000	50-37000	244
Selenium	3/20	(0.01)a	0.30-0.70	NA	0.64	0.3	0.1-3.9	0.35
Silver	1/20	0.56-1.9	21.8	0.52	21.8	NA	NA	<0.67
Sodium	5/20	27.8-147	41.6-91.3	29.37	91.3	2500	500-50000	47.0
Thallium	20/20	0.30	0.58-1.6	0.96	7	7.7	2.2-23	7.0
Vanadium	19/20	10.4	12.5-63.8	23.25	53.8	43	7-300	18.2
Zinc	20/20	(0.02)a	29.9-547	85.15	547	40	5-2900	47.6
VOLATILES								
1,1-Dichloroethane	2/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
1,1-Dichloroethene	2/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
1,1,1-Trichloroethane	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
1,1,2-Trichloroethane	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
1,1,2,2-Tetrachloroethane	7/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
1,2-Dichloroethane	2/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
1,2-Dichloroethene	2/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
1,2-Dichloropropane	2/20	0.005-0.008	0.006-0.007	0.003	0.008	NA	NA	<0.005
1,3-Dichloropropene (Cis)	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
1,3-Dichloropropene (Trans)	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
2-Butanone	0/20	0.011	NA	NA	NA	NA	NA	NA
2-Hexanone	5/20	0.010-0.015	0.012-0.016	0.008	0.016	NA	NA	<0.011
4-Methyl-2-Pentanone	8/20	0.011-0.015	0.012-0.016	0.008	0.016	NA	NA	<0.011
Acetone	1/20	0.010-0.039	0.19	0.009	0.19	NA	NA	<0.011
Benzene	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Bromodichloromethane	2/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Bromoforn	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Bromomethane	2/20	0.010-0.015	0.012-0.014	0.007	0.014	NA	NA	<0.011
Carbon disulfide	2/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
Carbon Tetrachloride	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Chlorobenzene	7/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
Chloroethane	2/20	0.010-0.016	0.012-0.014	0.007	0.014	NA	NA	<0.011
Chloroforn	3/20	0.005-0.008	0.006-0.007	0.003	0.007	NA	NA	<0.005
Chloromethane	2/20	0.010-0.016	0.012-0.014	0.007	0.014	NA	NA	<0.011
Dibromochloromethane	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Ethylbenzene	7/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
Methylene chloride	0/20	0.009-0.038	NA	NA	NA	NA	NA	<0.009
Styrene	7/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
Tetrachloroethene	8/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
Toluene	8/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005
Trichloroethene	3/20	0.005-0.008	0.006-0.008	0.003	0.008	NA	NA	<0.005
Vinyl acetate	3/20	0.010-0.016	0.012-0.016	0.007	0.016	NA	NA	<0.011
Vinyl chloride	2/20	0.010-0.016	0.012-0.014	0.007	0.014	NA	NA	<0.011
Xylenes	7/20	0.005-0.008	0.006-0.008	0.004	0.008	NA	NA	<0.005

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)

b. U S background range and average concentration are from (USGS, 1984)

c. Average U S background (Carey, 1979)

d. On site background values are from wb-5, at a depth of 0-2 feet

TABLE 3-1 (cont.)
SUMMARY OF SURFACE SOIL DATA
OF MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg) ^b	RANGE OF U S BACKGROUND (mg/kg) ^b	ON SITE BACKGROUND LEVELS (mg/kg) ^d
0								
SEMIVOLATILES								
1,2-Dichlorobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
1,2,4-Trichlorobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
1,3-Dichlorobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
1,4-Dichlorobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2-Chloronaphthalene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2-Chlorophenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2-Methylnaphthalene	2/20	0.36-2.5	0.12-1.2	0.292	1.2	NA	NA	<0.40
2-Methylphenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2-Nitroaniline	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
2-Nitrophenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2,4-Dichlorophenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2,4-Dimethylphenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2,4-Dinitrophenol	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
2,4-Dinitrotoluene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2,4,5-Trichlorophenol	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
2,4,6-Trichlorophenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
2,6-Dinitrotoluene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
3-Nitroaniline	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
3,3'-Dichlorobenzidine	0/20	0.72-5.0	NA	NA	NA	NA	NA	<0.81
4-Bromophenyl-phenylether	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
4-Chloro-3-methylphenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
4-Chloroaniline	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
4-Chlorophenyl-phenylether	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
4-Methylphenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
4-Nitroaniline	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
4-Nitrophenol	1/20	1.8-13	54	1.344	0.54	NA	NA	<2.0
4,6-dinitro-2-methylphenol	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
Acenaphthene	3/20	0.36-2.5	0.047-0.37	0.278	0.37	NA	NA	<0.40
Acenaphthylene	7/20	0.40-2.5	0.045-1.5	0.249	1.5	NA	NA	<0.40
Anthracene	8/20	0.36-2.00	0.078-2.0	0.271	2.4	NA	NA	<0.40
Benzoic acid	1/20	1.8-13	0.048	1.188	0.048	NA	NA	0.048
Benzo(a)anthracene	15/20	0.4-0.51	0.087-9.8	0.438	9.8	NA	NA	<0.40
Benzo(a)pyrene	14/20	0.4-0.69	0.081-7.5	0.453	7.5	NA	NA	<0.40
Benzo(b)fluoranthene	15/20	0.4-0.51	0.069-6.4	0.477	6.4	NA	NA	<0.40
Benzo(g,h)perylene	9/20	0.36-0.69	0.2-3.4	0.384	3.4	NA	NA	<0.40
Benzo(k)fluoranthene	14/20	0.4-0.69	0.081-6.8	0.454	6.8	NA	NA	<0.40
Benzyl Alcohol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Bis(2-chloroethoxy)methane	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Bis(2-chloroethyl)ether	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Bis(2-chloroisopropyl)ether	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Bis(2-ethylhexyl)phthalate	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Butylbenzylphthalate	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Chrysene	16/20	0.4-0.48	0.057-11.0	0.504	11	NA	NA	<0.40
Dibenzofuran	2/20	0.36-2.5	0.25-0.45	0.270	0.45	NA	NA	<0.40
Dibenzo(a,h)anthracene	7/20	0.36-0.69	0.022-1.6	0.278	1.6	NA	NA	<0.40
Dibenzophthalate	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Dimethylphthalate	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Dn-n-butylphthalate	1/20	0.36-2.5	0.063	0.283	NA	NA	NA	<0.40
Dn-n-octylphthalate	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Fluoranthene	17/20	0.4-0.48	0.068-15.0	0.647	15	NA	NA	<0.1
Fluorene	5/20	0.36-2.00	0.064-2.5	0.285	2.5	NA	NA	<0.40
Hexachlorobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Hexachlorobutadiene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Hexachlorocyclopentadiene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Hexachloroethane	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Indeno(1,2,3-cd)pyrene	9/20	0.36-0.69	0.24-3.3	0.384	3.3	NA	NA	<0.40
Isophorone	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Naphthalene	4/20	0.36-2.5	0.046-0.45	0.254	0.45	NA	NA	<0.40
Nitrobenzene	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
N-nitroso-d-n-propylamine	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
N-nitrosodiphenylamine	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Pentachlorophenol	0/20	1.8-13	NA	NA	NA	NA	NA	<2.0
Phenanthrene	15/20	0.40-0.51	0.048-14.0	0.423	14	NA	NA	<0.40
Phenol	0/20	0.36-2.5	NA	NA	NA	NA	NA	<0.40
Pyrene	17/20	0.4-0.48	0.057-15.0	0.801	15	NA	NA	<0.10
0								
PESTICIDES								
4,4'-DDD	1/20	0.019-0.38	0.005	0.028	0.005	NA	NA	<0.018
4,4'-DDE	12/20	0.019-0.38	0.0062-0.13	0.032	0.13	NA	NA	<0.018
4,4'-DDT	15/20	0.019-0.38	0.016-0.45	0.065	0.45	NA	NA	<0.0058
Aldrin	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Alpha-BHC	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Alpha-chlordane	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.0088
Beta-BHC	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Delia drin	0/20	0.019-0.38	NA	NA	NA	NA	NA	<0.018
Delta-BHC	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Endosulfan I	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Endosulfan II	0/20	0.019-0.38	NA	NA	NA	NA	NA	<0.018
Endosulfan Sulfate	0/20	0.019-0.38	NA	NA	NA	NA	NA	<0.018
Endrin	0/20	0.019-0.38	NA	NA	NA	NA	NA	<0.018
Endrin ketone	0/20	0.019-0.38	NA	NA	NA	NA	NA	<0.018
Gamma-BHC	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Gamma-chlordane	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.0088
Heptachlor	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Heptachlor epoxide	0/20	0.0096-0.18	NA	NA	NA	NA	NA	<0.0088
Methoxychlor	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.0088
Toxaphene	0/20	0.190-3.8	NA	NA	NA	NA	NA	<0.18
PCB's								
Aroclor-1018	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.18
Aroclor-1221	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.18
Aroclor-1232	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.18
Aroclor-1242	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.18
Aroclor-1248	0/20	0.0096-1.9	NA	NA	NA	NA	NA	<0.18
Aroclor-1254	1/20	0.19-3.8	0.210	0.284	NA	NA	NA	<0.36
Aroclor-1260	7/20	0.19-0.95	0.043-8.0	0.274	0.27	NA	NA	<0.36

- a SQLs in parenthesis are the contract required quantitation limits (CQRL)
b U S background range and average concentration are from (USGS, 1984)
c Average U S background (Carey, 1979)
d On site background values are from wb-5, at a depth of 0-2 feet

TABLE 3-2
SUMMARY OF SUBSURFACE SOIL DATA
FOR MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	ON SITE MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
INORGANICS							
Aluminum	34/34	(0.2)a	1630-15600	7276.1	15600	33000	7000-100000
Antimony	22/34	4.2-15.3	3.5-1810	19.0	1810	0.52	<1-8.8
Arsenic	33/34	0.36	1.3-35.95	5.3	35.95	4.8	0.1-73
Barium	34/34	(0.2)a	8.7-1360	48.1	1360	290	10-1500
Beryllium	32/34	0.2-0.35	0.18-1.4	0.3	1.4	0.55	1-7
Cadmium	25/34	0.53-1.1	0.51-32.9	1.8	32.9	0.26 c	NA
Calcium	34/34	(5.0)a	230-17100	1938.6	17100	3400	100-280000
Chromium	34/34	(0.01)a	4.6-274	27.7	274	33	1-1000
Cobalt	34/34	(0.05)a	1.8-74.3	13.4	74.3	5.9	0.3-70
Copper	34/34	(0.025)a	10.5-24400	226.3	24400	13	1-700
Cyanide	6/34	0.55-0.91	69-1.1	0.4	1.1	NA	NA
Iron	34/34	(0.1)a	5900-206500	30503.8	206500	14000	100-100000
Lead	34/34	(0.005)a	1.0-8920	107.4	8920	14	10-300
Magnesium	34/34	(5.0)a	709-4180	2202.6	4180	2100	50-50000
Manganese	34/34	(0.015)a	71.2-1189	364.5	1189	260	2-7000
Mercury	18/34	1-18	12-1	0.2	1	0.061	0.01-3.4
Nickel	34/34	(0.04)a	4.5-427	39.6	427	11	5-700
Potassium	34/34	(5)a	153-1220	353.6	1220	12000	50-37000
Selenium	19/34	0.33-2	0.28-2.5	0.4	2.5	0.3	0.1-3.9
Silver	15/34	0.51-2.2	0.48-15.2	1.0	15.2	NA	NA
Sodium	23/34	17.5-296	31.2-682	94.2	682	2500	500-50000
Thallium	27/34	0.56-0.97	0.3-9.1	0.9	9.1	7.7	2.2-23
Vanadium	34/34	(0.05)a	7.8-645	47.9	645	43	7-300
Zinc	34/34	(0.02)a	20-23935	540.1	23935	40	5-2900
VOLATILES							
1,1-Dichloroethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,1-Dichloroethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,1,1-Trichloroethane	7/36	0.005-0.03	0.006-0.2	0.003	0.2	NA	NA
1,1,2-Trichloroethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,1,2,2-Tetrachloroethane	9/36	0.005-0.03	0.006-0.04	0.004	0.04	NA	NA
1,2-Dichloroethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,2-Dichloroethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,2-Dichloropropane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,3-Dichloropropane (Cis)	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
1,3-Dichloropropane (Trans)	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
2-Butanone	3/36	0.011	0.007-1.7	0.028	1.7	NA	NA
2-Hexanone	10/36	0.01-0.06	0.011-1.6	0.006	1.6	NA	NA
4-Methyl-2-Pentanone	10/36	0.01-0.06	0.011-1.6	0.007	1.6	NA	NA
Acetone	5/36	0.008-0.44	0.24-6.2	0.009	6.2	NA	NA
Benzene	6/36	0.005-0.03	0.006-0.3165	0.004	0.3165	NA	NA
Bromodichloromethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
Bromoform	7/36	0.005-0.03	0.006-0.82	0.003	0.82	NA	NA
Bromomethane	6/36	0.01-0.06	0.011-0.079	0.006	0.079	NA	NA
Carbon disulfide	7/36	0.005-0.03	0.002-0.04	0.003	0.04	NA	NA
Carbon Tetrachloride	10/36	0.005-0.03	0.005-0.04	0.004	0.04	NA	NA
Chlorobenzene	12/36	0.005-0.03	0.005-1.5	0.004	1.5	NA	NA
Chloroethane	6/36	0.01-0.06	0.011-0.079	0.006	0.079	NA	NA
Chloroform	6/36	0.002-0.03	0.006-0.04	0.003	0.04	NA	NA
Chloromethane	6/36	0.01-0.06	0.011-0.079	0.006	0.079	NA	NA
Dibromochloromethane	6/36	0.005-0.03	0.006-0.04	0.003	0.04	NA	NA
Ethylbenzene	12/36	0.005-0.03	0.006-2.3	0.004	2.3	NA	NA
Methylene chloride	0/36	0.006-2.0	NA	NA	0.06	NA	NA
Styrene	9/36	0.005-0.03	0.006-0.04	0.004	0.04	NA	NA
Tetrachloroethane	10/36	0.005-0.03	0.004-0.04	0.003	0.04	NA	NA
Toluene	10/36	0.005-0.03	0.001-0.72	0.004	0.72	NA	NA
Trichloroethane	9/36	0.005-0.03	0.002-0.04	0.003	0.04	NA	NA
Vinyl acetate	6/36	0.01-0.06	0.011-0.079	0.006	0.079	NA	NA
Vinyl chloride	6/36	0.01-0.06	0.006-0.079	0.006	0.079	NA	NA
Xylenes	13/36	0.005-0.03	0.003-11.0	0.004	11	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQL)

b. U.S. background range and average concentration are from (USGS, 1984)

c. Average U.S. background (Carey, 1979)

NA Not Applicable

TABLE 3-2 (cont.)
SUMMARY OF SUBSURFACE SOIL DATA
FOR MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	ON SITE MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
SEMIVOLATILES							
1,2-Dichlorobenzene	1/36	0.4-9.1	0.74	0.398	0.74	NA	NA
1,2,4-Trichlorobenzene	1/36	0.4-9.1	0.51	0.393	0.51	NA	NA
1,3-Dichlorobenzene	1/36	0.4-9.1	1.6	0.405	1.6	NA	NA
1,4-Dichlorobenzene	1/36	0.4-9.1	7.9	0.424	7.9	NA	NA
2-Chloronaphthalene	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
2-Chlorophenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
2-Methylnaphthalene	16/36	0.4-2.0	0.1-24.0	0.606	24	NA	NA
2-Methylphenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
2-Nitroaniline	2/36	2.0-45	11.0	2.062	11	NA	NA
2-Nitrophenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
2,4-Dichlorophenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
2,4-Dimethylphenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
2,4-Dinitrophenol	2/36	2.0-45	11.0	2.137	11	NA	NA
2,4-Dinitrotoluene	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
2,4,5-Trichlorophenol	2/36	2.0-45	11.0	2.137	11	NA	NA
2,4,6-Trichlorophenol	2/36	0.4-9.1	2.1-2.2	0.426	2.2	NA	NA
2,6-Dinitrotoluene	2/36	0.4-9.1	2.1-2.2	0.436	2.2	NA	NA
3-Nitroaniline	9/36	2.0-45	2.0-13.0	2.246	13	NA	NA
3,3'-Dichlorobenzidine	10/36	0.8-18	0.79-5.2	0.974	4.4	NA	NA
4-Bromophenyl-phenylether	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
4-Chloro-3-methylphenol	0/36	0.4-9.1	NA	NA	NA	NA	NA
4-Chloroaniline	0/36	0.4-9.1	NA	NA	NA	NA	NA
4-Chlorophenyl-phenylether	2/36	0.4-9.1	2.1-2.2	0.417	NA	NA	NA
4-Methylphenol	1/36	0.4-9.1	0.87	0.409	0.87	NA	NA
4-Nitroaniline	2/36	2.0-45	11.0	2.062	11	NA	NA
4-Nitrophenol	2/36	2.0-45	11.0	2.137	11	NA	NA
4,6-Dinitro-2-methylphenol	2/36	2.0-45	11.0	2.137	11	NA	NA
Acenaphthene	10/36	0.4-2.3	0.12-5.5	0.412	5.5	NA	NA
Acenaphthylene	4/36	0.4-2.35	0.410-2.2	0.394	2.2	NA	NA
Anthracene	12/36	0.4-9.1	0.066-4.0	0.412	4	NA	NA
Benzoic acid	3/36	2.0-45	0.22-3.60	1.913	3.6	NA	NA
Benzo(a)anthracene	20/36	0.4-1.3	0.074-6.8	0.331	6.8	NA	NA
Benzo(a)pyrene	21/36	0.4-1.9	0.059-5.6	0.346	5.6	NA	NA
Benzo(b)fluoranthene	19/36	0.4-2.3	0.078-4.8	0.350	4.8	NA	NA
Benzo(ghi)perylene	14/36	0.4-9.1	0.06-3.7	0.402	3.7	NA	NA
Benzo(k)fluoranthene	19/36	0.4-2.3	0.062-3.6	0.324	3.6	NA	NA
Benzyl Alcohol	0/36	0.4-9.1	NA	NA	NA	NA	NA
Bis(2-chloroethoxy)methane	0/36	0.4-9.1	NA	NA	NA	NA	NA
Bis(2-chloroethyl)ether	10/36	0.23-9.1	0.4-2.6	0.477	1.3	NA	NA
Bis(2-chloroisopropyl)ether	0/36	0.4-9.1	NA	NA	NA	NA	NA
Bis(2-ethylhexyl)phthalate	2/36	0.14-11	0.4-2.1	0.413	2.1	NA	NA
Butylbenzylphthalate	3/36	0.4-9.1	0.4-2.2	0.425	2.2	NA	NA
Chrysene	22/36	0.4-1.3	0.044-6.4	0.365	6.4	NA	NA
Dibenzofuran	6/36	0.4-9.1	0.1-7.6	0.426	2.2	NA	NA
Dibenz(o,h)anthracene	7/36	0.4-9.1	0.40-2.1	0.436	2.1	NA	NA
Diethylphthalate	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
Dimethylphthalate	3/36	0.4-9.1	0.046-2.2	0.401	2.2	NA	NA
Di-n-butylphthalate	2/36	0.069-4.7	2.1-2.2	0.395	2.2	NA	NA
Di-n-octylphthalate	5/36	0.4-9.1	0.4-2.1	0.442	2.1	NA	NA
Fluoranthene	24/36	0.4-1.3	0.053-18	0.408	18	NA	NA
Fluorene	13/36	0.4-2.3	0.12-10.0	0.486	10	NA	NA
Hexachlorobenzene	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
Hexachlorobutadiene	0/36	0.4-9.1	NA	NA	NA	NA	NA
Hexachlorocyclopentadiene	2/36	0.4-9.1	2.1-2.2	0.401	1.1	NA	NA
Hexachloroethane	0/36	0.4-9.1	NA	NA	NA	NA	NA
Indeno(123c-d)pyrene	12/36	0.4-9.1	0.081-3.2	0.410	3.2	NA	NA
Isophorone	0/36	0.4-9.1	NA	NA	NA	NA	NA
Naphthalene	14/36	0.4-2.3	0.066-17.0	0.470	17	NA	NA
Nitrobenzene	0/36	0.4-9.1	NA	NA	NA	NA	NA
N-nitroso-di-n-propylamine	0/36	0.4-9.1	NA	NA	NA	NA	NA
N-nitrosodiphenylamine	2/36	0.4-9.1	2.1-2.2	0.417	2.2	NA	NA
Pentachlorophenol	2/36	2.0-45.0	11.0	2.041	11	NA	NA
Phenanthrene	23/36	0.4-1.3	0.067-28.0	0.655	28	NA	NA
Phenol	2/36	0.4-9.1	0.22-0.33	0.414	0.33	NA	NA
Pyrene	25/36	0.4-1.3	0.041-15.0	0.436	15	NA	NA
PESTICIDES							
4,4'-DDD	1/36	1.7-2.0	0.0056	0.040	0.0056	NA	NA
4,4'-DDE	2/36	1.7-2.0	0.0024-0.0047	0.037	0.0047	NA	NA
4,4'-DDT	5/36	0.0056-2.0	0.0036-0.017	0.036	0.017	NA	NA
Aldrin	1/36	0.0086-0.98	0.0031	0.020	0.0031	NA	NA
Alpha-BHC	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Alpha-chlordane	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Beta-BHC	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Dieldrin	0/36	1.7-2.0	NA	NA	NA	NA	NA
Delta-BHC	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Endosulfan I	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Endosulfan II	0/36	1.7-2.0	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/36	1.7-2.0	NA	NA	NA	NA	NA
Endrin	0/36	1.7-2.0	NA	NA	NA	NA	NA
Endrin ketone	0/36	1.7-2.0	NA	NA	NA	NA	NA
Gamma-BHC	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Gamma-chlordane	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Heptachlor	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Heptachlor epoxide	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Methoxychlor	0/36	0.0086-0.98	NA	NA	NA	NA	NA
Toxaphene	0/36	0.17-20.0	NA	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/36	0.0086-9.8	NA	NA	NA	NA	NA
Aroclor-1221	0/36	0.0086-9.8	NA	NA	NA	NA	NA
Aroclor-1232	0/36	0.0086-9.8	NA	NA	NA	NA	NA
Aroclor-1242	0/36	0.0086-9.8	NA	NA	NA	NA	NA
Aroclor-1248	0/36	0.0086-9.8	NA	NA	NA	NA	NA
Aroclor-1254	6/36	0.17-20.0	0.067-1.9	0.371	1.9	NA	NA
Aroclor-1260	5/36	0.17-2.0	0.24-27.0	0.406	27	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
b. U S background (range and average concentration are from (USGS, 1984)
c. Average U S background (Carey, 1979)
NA Not Applicable

TABLE 3-3
SUMMARY OF MONITORING WELL DATA
FOR MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION (ug/l)	RANGE OF SQL (ug/l)	RANGE OF DETECTION (ug/l)	GEOMETRIC MEAN OF CONCENTRATION (ug/l)	MAXIMUM CONCENTRATION (ug/l)	ON SITE BACKGROUND LEVELS (ug/l) ^b
INORGANICS						
Aluminum	5/5	(200)	1080-93200	15000	28200	93200
Antimony	0/5	22-118	NA	NA	NA	<48.1
Arsenic	5/5	(10)	3.3-22.4	9	13	22.4
Barium	5/5	(200)	59.4-759	277	759	356
Beryllium	3/5	1	1.1-3.8	1	2	3.8
Cadmium	2/5	3	10.1-14.7	5	15	<3.0
Calcium	5/5	(5000)	22900-77100	43915	52500	77100
Chromium	4/5	2	5.7-121	22	63	121
Cobalt	4/5	8.3	32.9-192	38	55	192
Copper	5/5	(25)	32.5-958	143	958	133
Cyanide	0/5	10	NA	NA	NA	<10
Iron	5/5	(100)	18000-208000	73102	122000	208000
Lead	5/5	(5)	23.5-980	111	980	28.5
Magnesium	5/5	(5000)	9690-34400	16267	18100	34400
Manganese	5/5	(15)	549-4210	1716	4210	3600
Mercury	2/5	2	0.58-1.8	0	2	<0.2
Nickel	3/5	17.2-37.3	125-221	75	137	221
Potassium	5/5	(5000)	2260-9730	5216	9730	6690
Selenium	0/5	2-20	NA	NA	NA	<20
Silver	0/5	3-11.2	NA	NA	NA	<11.2
Sodium	5/5	(5000)	19100-32700	23370	27500	32700
Thallium	5/5	(10)	4	4	4	4.0
Vanadium	2/5	14.3-34.2	137-203	61	203	<34.2
Zinc	5/5	(20)	126-4170	780	4170	478
VOLATILES						
1,1-Dichloroethane	1/5	5-25	5	6.9	5	<5
1,1-Dichloroethene	1/5	5-25	5	6.9	5	<5
1,1,1-Trichloroethane	1/5	5-25	5	6.9	5	<5
1,1,2-Trichloroethane	1/5	5-25	5	6.9	5	<5
1,1,2,2-Tetrachloroethane	1/5	5-25	5	6.9	5	<5
1,2-Dichloroethane	1/5	5-25	5	6.9	5	<5
1,2-Dichloroethene	1/5	5-25	5	6.9	5	<5
1,2-Dichloropropane	1/5	5-25	5	6.9	5	<5
1,3-Dichloropropane (cis)	1/5	5-25	5	6.9	5	<5
1,3-Dichloropropane (trans)	1/5	5-25	5	6.9	5	<5
2-Butanone	1/5	10-25	10	12.0	10	<10
2-Hexanone	1/5	10-25	10	12.0	10	<10
4-Methyl-2-Pentanone	1/5	10-50	10	13.8	10	<10
Acetone	1/5	3-93	10	12.3	10	<10
Benzene	3/5	5	3-49	9.0	49	<5
Bromodichloromethane	1/5	5-25	5	6.9	5	<5
Bromoforn	1/5	5-25	5	6.9	5	<5
Bromomethane	1/5	10-50	10	13.8	10	<10
Carbon disulfide	1/5	5-25	5	6.9	5	<5
Carbon Tetrachloride	1/5	5-25	5	6.9	5	<5
Chlorobenzene	3/5	5	5-79	8.7	79	<5
Chloroethane	1/5	5	10-50	13.8	10	<10
Chloroform	1/5	5-25	5	6.9	5	<5
Chloromethane	1/5	10-50	10	13.8	10	<10
Dibromochloromethane	1/5	5-25	5	6.9	5	<5
Ethylbenzene	2/5	5	5-44	7.7	44	<5
Methylene chloride	0/5	13-93	NA	NA	NA	<19
Styrene	1/5	5-25	5	6.9	5	<5
Tetrachloroethane	1/5	5-25	5	6.9	5	<5
Toluene	2/5	5	5-8	5.2	8	<5
Trichloroethane	1/5	5-25	5	6.9	5	<5
Vinyl acetate	1/5	10-50	10	13.8	10	<10
Vinyl chloride	1/5	10-50	10	13.8	10	<10
Xylenes	2/5	5	5-110	9.3	110	<5

a Sample Quantitation Limits (SQLs) found in parenthesis are
Contract required Quantitation Limits (CQRLs)
NA not applicable
b On site Background values from monitoring well #5

TABLE 3-3 (cont.)
SUMMARY OF MONITORING WELL DATA
FOR MELVILLE NORTH LANDFILL

COMPOUND NAME	FREQUENCY OF DETECTION (ug/l)	RANGE OF SQL (ug/l)	RANGE OF DETECTION (ug/l)	GEOMETRIC MEAN OF CONCENTRATION (ug/l)	MAXIMUM CONCENTRATION (ug/l)	ON SITE BACKGROUND LEVELS (ug/l)b
SEMIVOLATILES						
1,2-Dichlorobenzene	0/5	10-50	NA	NA	NA	<10
1,2,4-Trichlorobenzene	0/5	10-50	NA	NA	NA	<10
1,3-Dichlorobenzene	1/5	10-50	14	15.0	14	<10
1,4-Dichlorobenzene	1/5	10-50	83	21.5	83	<10
2-Chloronaphthalene	0/5	10-50	NA	NA	NA	<10
2-Chlorophenol	0/5	10-50	NA	NA	NA	<10
2-Methylnaphthalene	2/5	10-11	9-210	18.3	210	<10
2-Methylphenol	0/5	10-50	NA	NA	NA	<10
2-Nitroaniline	0/5	50-250	NA	NA	NA	<50
2-Nitrophenol	0/5	10-50	NA	NA	NA	<10
2,4-Dichlorophenol	0/5	10-50	NA	NA	NA	<10
2,4-Dimethylphenol	0/5	10-50	NA	NA	NA	<10
2,4-Dinitrophenol	0/5	50-250	NA	NA	NA	<50
2,4-Dinitrotoluene	0/5	10-50	NA	NA	NA	<10
2,4,5-Trichlorophenol	0/5	50-250	NA	NA	NA	<50
2,4,6-Trichlorophenol	0/5	10-50	NA	NA	NA	<10
2,6-Dinitrotoluene	0/5	10-50	NA	NA	NA	<10
3-Nitroaniline	0/5	50-250	NA	NA	NA	<50
3,3'-Dichlorobenzidine	0/5	20-100	NA	NA	NA	<20
4-Bromophenyl-phenylether	0/5	10-50	NA	NA	NA	<10
4-Chloro-3-methylphenol	0/5	10-50	NA	NA	NA	<10
4-Chloroaniline	0/5	10-50	NA	NA	NA	<10
4-Chlorophenyl-phenylether	0/5	10-50	NA	NA	NA	<10
4-Methylphenol	0/5	10-50	NA	NA	NA	<10
4-Nitroaniline	0/5	50-250	NA	NA	NA	<50
4-Nitrophenol	0/5	50-250	NA	NA	NA	<50
4,6-Dinitro-2-methylphenol	0/5	50-250	NA	NA	NA	<50
Acenaphthene	1/5	10-50	17	15.6	17	<10
Acenaphthylene	0/5	10-50	NA	NA	NA	<10
Anthracene	1/5	10-50	12	14.6 12	NA	<10
Benzoic acid	0/5	50-250	NA	NA	NA	<50
Benzo(a)anthracene	0/5	10-50	NA	NA	NA	<10
Benzo(a)pyrene	0/5	10-50	NA	NA	NA	<10
Benzo(b)fluoranthene	0/5	10-50	NA	NA	NA	<10
Benzo(ghi)perylene	0/5	10-50	NA	NA	NA	<10
Benzo(k)fluoranthene	0/5	10-50	NA	NA	NA	<10
Benzyl Alcohol	0/5	10-50	NA	NA	NA	<10
Bis(2-chloroethoxy)methane	0/5	10-50	NA	NA	NA	<10
Bis(2-chloroethyl)ether	0/5	10-50	NA	NA	NA	<10
Bis(2-chloroisopropyl)ether	0/5	10-50	NA	NA	NA	<10
Bis(2-ethylhexyl)phthalate	1/5	10-50	13	14.8	13	<10
Butylbenzylphthalate	0/5	10-50	NA	NA	NA	<10
Chrysene	0/5	10-50	NA	NA	NA	<10
Dibenzofuran	0/5	10-50	NA	NA	NA	<10
Dibenzo(a,h)anthracene	0/5	10-50	NA	NA	NA	<10
Diethylphthalate	0/5	10-50	NA	NA	NA	<10
Dimethylphthalate	0/5	10-50	NA	NA	NA	<10
Di-n-butylphthalate	0/5	10-50	NA	NA	NA	<10
Di-n-octylphthalate	0/5	10-50	NA	NA	NA	<10
Fluoranthene	0/5	10-50	NA	NA	NA	<10
Fluorene	0/5	10-50	NA	NA	NA	<10
Hexachlorobenzene	0/5	10-50	NA	NA	NA	<10
Hexachlorobutadiene	0/5	10-50	NA	NA	NA	<10
Hexachlorocyclopentadiene	0/5	10-50	NA	NA	NA	<10
Hexachloroethane	0/5	10-50	NA	NA	NA	<10
Indeno(123cd)pyrene	0/5	10-50	NA	NA	NA	<10
Isophorone	0/5	10-50	NA	NA	NA	<10
Naphthalene	2/5	10-11	7-100	15.0	100	<10
Nitrobenzene	0/5	10-50	NA	NA	NA	<10
N-Nitroso-di-n-propylamine	0/5	10-50	NA	NA	NA	<10
N-Nitrosodiphenylamine	0/5	10-50	NA	NA	NA	<10
Pentachlorophenol	0/5	5-250	NA	NA	NA	<50
Phenanthrene	2/5	10-11	11-62	15.0	62	<10
Phenol	0/5	10-50	NA	NA	NA	<10
Pyrene	1/5	10-50	20	16.2	20	<10
PESTICIDES						
1,1'-DDD	0/5	0.1-1	NA	NA	NA	<0.1
1,1'-DDE	0/5	0.1-1	NA	NA	NA	<0.1
1,1'-DDT	0/5	0.1-1	NA	NA	NA	<0.1
Aldrin	0/5	0.05-0.5	NA	NA	NA	<0.05
Alpha-BHC	0/5	0.05-0.5	NA	NA	NA	<0.05
Alpha-Chlordane	0/5	0.5-5	NA	NA	NA	<0.5
Beta-BHC	0/5	0.05-0.5	NA	NA	NA	<0.05
Dieldrin	0/5	0.1-1	NA	NA	NA	<0.1
Delta-BHC	0/5	0.05-0.5	NA	NA	NA	<0.05
Endosulfan I	0/5	0.05-0.5	NA	NA	NA	<0.05
Endosulfan II	0/5	0.1-1	NA	NA	NA	<0.1
Endosulfan Sulfate	0/5	0.1-1	NA	NA	NA	<0.1
Endrin	0/5	0.1-1	NA	NA	NA	<0.1
Endrin ketone	0/5	0.1-1	NA	NA	NA	<0.1
Gamma-BHC	1/5	0.05-0.1	0.13	0.1	0.13	<0.05
Gamma-Chlordane	0/5	0.5-5	NA	NA	NA	<0.5
Heptachlor	0/5	0.05-0.5	NA	NA	NA	<0.05
Heptachlor epoxide	0/5	0.05-0.5	NA	NA	NA	<0.05
Methoxychlor	0/5	0.5-5	NA	NA	NA	<0.5
Toxaphene	0/5	1-10	NA	NA	NA	<1.0
PCB's						
Aroclor-1016	0/5	0.5-5	NA	NA	NA	<0.5
Aroclor-1221	0/5	0.5-5	NA	NA	NA	<0.5
Aroclor-1232	0/5	0.5-5	NA	NA	NA	<0.5
Aroclor-1242	0/5	0.5-5	NA	NA	NA	<0.5
Aroclor-1248	0/5	0.5-5	NA	NA	NA	<0.5
Aroclor-1254	0/5	1-10	NA	NA	NA	<1.0
Aroclor-1260	2/5	1	0.22-40	1.5	40	<1.0

a Sample Quantitation Limits (SQLs) found in parenthesis are
Contract required Quantitation Limits (CQRLs)
NA not applicable
b On site Background values from monitoring well #5

TABLE 3-4
SUMMARY OF CONTAMINANTS
MELVILLE NORTH LANDFILL

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (µg/L)
INORGANICS			
Aluminum	2900-12700	1630-15600	1060-93200
Antimony	&	4.9-50.4	ND
Arsenic	&*	2.1-23.4	3.3-22.4
Barium	&	8.5-299	60.4-759
Beryllium	&*	0.10-0.52	1.1-3.8
Cadmium	&***	0.6-1.2	10.1-14.7
Calcium		337-6720	22600-77100
Chromium	&*	5.1-35.2	5.7-121
Cobalt	&*	3.2-16.7	32.9-182
Copper	&**	12.2-200	32.5-958
Cyanide		0.78-1.5	ND
Iron		7670-29100	18000-208000
Lead	&**	10.2-400.5	23.5-960
Magnesium	&	958-4530	9690-34400
Manganese		108-600	549-4210
Mercury	&	0.14-1.1	0.38-1.8
Nickel	&***	6-32.2	126-221
Potassium		228-472	2260-9730
Selenium		0.30-0.70	ND
Silver		21.8	ND
Sodium		41.8-91.3	19100-32700
Thallium	&**	0.58-1.8	4
Vanadium	&	12.5-53.8	137-203
Zinc	&	29.8-547	126-4170
VOLATILES			
1,1-Dichloroethane	X 0.006-0.007	X 0.006-0.04	X 5
1,1-Dichloroethane	&*	X 0.006-0.007	X 5
1,1,1-Trichloroethane	&	X 0.006-0.008	X 5
1,1,2-Trichloroethane	&*	X 0.006-0.008	X 5
1,1,2,2-Tetrachloroethane	&*	X 0.006-0.008	X 5
1,2-Dichloroethane	&*	X 0.006-0.007	X 5
1,2-Dichloroethane		X 0.006-0.007	X 5
1,2-Dichloropropane	&*	X 0.006-0.007	X 5
1,3-Dichloropropane (Gis)	&*	X 0.006-0.008	X 5
1,3-Dichloropropane (Trans)	&*	X 0.006-0.008	X 5
2-Butanone	&**	ND	X 10
2-Hexanone	&	0.012-0.016	X 0.011-1.8
4-Methyl-2-Pentanone	&	0.012-0.016	X 0.011-1.8
Acetone	&***	0.10	0.24-8.2
Benzene	&***	X 0.006-0.008	0.006-0.32
Bromodichloromethane	&*	X 0.006-0.008	X 0.006-0.04
Bromofom	&*	X 0.006-0.008	X 0.006-0.82
Bromomethane		X 0.012-0.014	X 0.011-0.079
Carbon disulfide		X 0.006-0.007	0.002-0.04
Carbon Tetrachloride	&*	X 0.006-0.008	X 0.006-0.04
Chlorobenzene	&	0.006-0.008	0.005-1.5
Chloroethane		X 0.012-0.014	X 0.011-0.079
Chloroform	&***	0.006-0.007	X 0.006-0.04
Chloromethane	&*	X 0.012-0.014	X 0.011-0.079
Dibromochloromethane	&*	X 0.006-0.008	X 0.006-0.04
Ethylbenzene	&*	0.006-0.008	0.006-2.3
Methylene chloride	&	ND	ND
Styrene	&*	0.006-0.008	X 0.006-0.04
Tetrachloroethane	&*	0.001-0.008	0.004-0.04
Toluene	&*	0.002-0.008	0.001-0.72
Trichloroethane	&*	X 0.006-0.008	0.002-0.04
Vinyl acetate		X 0.012-0.016	X 0.011-0.079
Vinyl chloride	&*	X 0.012-0.014	X 0.006-0.079
Xylenes	&*	0.006-0.008	0.003-11.0

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "U" qualified data only

ND Not Detected

TABLE 3-4 (cont.)
SUMMARY OF CONTAMINANTS
MELVILLE NORTH LANDFILL

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (ug/L)
SEMI-VOLATILES			
1,2-Dichlorobenzene	ND	0.74	ND
1,2,4-Trichlorobenzene	ND	0.51	ND
1,3-Dichlorobenzene	&	1.6	14
1,4-Dichlorobenzene	&	7.9	83
2-Chloronaphthalene	ND	X 2.1-2.2	ND
2-Chlorophenol	ND	ND	ND
2-Methylnaphthalene	&*	0.12-1.2	0.1-24.0
2-Methylphenol	ND	ND	ND
2-Nitroaniline	ND	X 11.0	ND
2-Nitrophenol	ND	ND	ND
2,4-Dichlorophenol	ND	ND	ND
2,4-Dimethylphenol	ND	ND	ND
2,4-Dinitrophenol	&*	ND	ND
2,4-Dinitrotoluene	ND	X 11.0	ND
2,4,6-Trichlorophenol	ND	X 2.1-2.2	ND
2,4,6-Trichlorophenol	ND	X 11.0	ND
2,6-Dinitrotoluene	ND	X 2.1-2.2	ND
2-Nitroaniline	&	X 2.0-13.0	ND
2,3'-Dichlorobenzidine	&	X 0.79-5.2	ND
4-Bromophenyl-phenylether	ND	X 2.1-2.2	ND
4-Chloro-3-methylphenol	ND	ND	ND
4-Chloroaniline	ND	ND	ND
4-Chlorophenyl-phenylether	ND	2.1-2.2	ND
4-Methylphenol	ND	0.87	ND
4-Nitroaniline	ND	X 11.0	ND
4-Nitrophenol	.54	X 11.0	ND
4,6-dinitro-2-methylphenol	ND	X 11.0	ND
Acenaphthene	&***	0.047-0.37	0.12-5.5
Acenaphthylene	&***	0.045-1.5	0.410-2.2
Anthracene	&***	0.078-2.0	0.086-4.0
Benzoic acid	ND	0.22-3.50	ND
Benzo(a)anthracene	&***	0.087-9.8	0.074-8.8
Benzo(a)pyrene	&***	0.081-7.5	0.059-5.5
Benzo(b)fluoranthene	&***	0.089-8.4	0.078-4.8
Benzo(ghi)perylene	&***	0.2-3.4	0.06-3.7
Benzo(k)fluoranthene	&***	0.081-8.8	0.062-3.6
Benzyl Alcohol	ND	ND	ND
Bis(2-chloroethoxy)methane	ND	ND	ND
Bis(2-chloroethyl)ether	ND	X 0.4-2.6	ND
Bis(2-chloroisopropyl)ether	ND	ND	ND
Bis(2-ethylhexyl)phthalate	&*	ND	X 0.4-2.1
Butylbenzylphthalate	ND	X 0.4-2.2	ND
Chrysene	&***	0.067-11.0	0.044-6.4
Dibenzofuran	ND	0.25-0.45	0.1-7.6
Dibenz(a,h)anthracene	&***	0.022-1.6	0.40-2.1
Dimethylphthalate	ND	X 2.1-2.2	ND
Dimethylphthalate	ND	0.046-2.2	ND
Di-n-butylphthalate	0.063	X 2.1-2.2	ND
Di-n-octylphthalate	ND	X 0.4-2.1	ND
Fluoranthene	&***	0.068-15.0	0.053-18
Fluorene	&***	0.064-2.5	0.12-10.0
Hexachlorobenzene	ND	X 2.1-2.2	ND
Hexachlorobutadiene	ND	ND	ND
Hexachlorocyclopentadiene	ND	X 2.1-2.2	ND
Hexachloroethane	ND	ND	ND
Indeno(1,2,3cd)pyrene	&***	0.24-3.3	0.081-3.2
Isochloro	ND	ND	ND
Naphthalene	&***	0.046-0.45	0.068-17.0
Nitrobenzene	ND	ND	7-100
N-nitroso-d-n-propylamine	ND	ND	ND
N-nitrosodiphenylamine	ND	X 2.1-2.2	ND
Pentachlorophenol	ND	X 11.0	ND
Phenanthrene	&***	0.048-14.0	0.067-28.0
Phenol	***	ND	0.22-0.33
Pyrene	&***	0.057-15.0	0.041-15.0
PESTICIDES			
4,4'-DDD	&***	0.005	0.0056
4,4'-DDE	&***	0.0062-0.13	0.0024-0.0047
4,4'-DDT	&*	0.018-0.45	0.0036-0.017
Aldrin	ND	0.0031	ND
Alpha-BHC	ND	ND	ND
Alpha-chlordane	ND	ND	ND
Beta-BHC	ND	ND	ND
Delta-BHC	ND	ND	ND
Endosulfen I	ND	ND	ND
Endosulfen II	ND	ND	ND
Endosulfen Sulfate	ND	ND	ND
Endrin	ND	ND	ND
Endrin ketone	ND	ND	ND
Gamma-BHC	ND	ND	0.13
Gamma-chlordane	ND	ND	ND
Heptachlor	ND	ND	ND
Heptachlor epoxide	ND	ND	ND
Methoxychlor	ND	ND	ND
Toxaphene	ND	ND	ND
PCB's			
Aroclor-1016	ND	ND	ND
Aroclor-1221	ND	ND	ND
Aroclor-1232	ND	ND	ND
Aroclor-1242	ND	ND	ND
Aroclor-1248	ND	ND	ND
Aroclor-1254	0.210	0.067-1.9	ND
Aroclor-1260	&***	0.043-8.0	0.22-40

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "UJ" qualified data only

ND Not detected

TABLE 3-6
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - MELVILLE NORTH LANDFILL

PARAMETER	VALUE OR RANGE	VALUE USED	RATIONALE	REFERENCE
Global variables				
Body Weight (kg)				
Children				
- scenario 1	36-61.2	49.2	Value based on average of males and females between 9-18 yrs	EPA 1990
- scenario 4	11.6-17.4	14.5	Value based on average of males and females between 0-6 yrs	EPA 1989
Adult	67.2-74.6	70	Value based on average of males and females between 18-65 yrs	EPA 1989
Exposure Duration (years)				
- scenario 1	1-18	9	Based upon the age range of children likely to enter the site	
- scenario 2	1-70	1	Amount of time spent building a marina (proposed).	
- scenario 3	1-70	25	National upper-bound (90th percentile) at one job.	EPA 1991
- scenario 4				
Child	1-6	6	Number of years in this age group.	EPA 1991
Adult	1-70	30	National upper-bound (90th percentile) at one residence.	EPA 1991
Averaging Time				
Cancer-risks (days)	NA	25,550	Value based upon 70 year life expectancy.	EPA 1989
Noncancer-risks (days)				
- scenario 1	350-25,550	9	Value based upon exposure duration.	
- scenario 2	1-365	250	Value based upon exposure duration.	
- scenario 3	350-25,550	6250	Value based upon exposure duration.	
- scenario 4				
Child	350-2,190	2100	Value based upon exposure duration.	
Adult	350-25,550	10,500	Value based upon exposure duration.	
Soil Contact Rate (mg/day)	500-1000	500	Soil deposition=0.5mg/m ² , skin surface area=2000cm ² ; fraction exposed=50%	EPA 1989a
Absorption Factor (no units)				
- Dermal.				
VOC's	0-1	0.5		EPA 1989a
PAHs/PCBs	0-1	0.05		EPA 1989a
Inorganics	0-1	negligible		EPA 1989a
Pesticides	0-1	0.05,0.5	High/Low soil sorption, respectively	EPA 1989a
- Ingestion				
VOC's, PAHs	0-1	1		EPA 1989a
Inorganics	0-1	1		EPA 1989a
Pesticides	0-1	0.3;1	High/Low soil sorption, respectively	EPA 1989a
Lead	0-1	0.5,0.3	Children, Adults, respectively	EPA 1989a
- Inhalation:	0-1	1	Complete absorption	EPA 1989a
Permeability Constant - Dermal contact in Water (cm/hr)		8.4E-04	Based upon the penetration rate of water	EPA 1989
Chemical Concentration Justification				EPA 1989a
Surface Soils, Subsurface soils; Ground Water			Geometric mean and maximum values used in exposure estimates were calculated using the methods described in text.	

TABLE 3-6
(continued)
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - MELVILLE NORTH LANDFILL

Scenario 1 - Trespassing Exposure: Current Use				
Exposure Frequency (days/year)	1-365	1	Based upon trespassing on an infrequent basis.	
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-200	100	Soil ingestion rate for those over 6 years of age.	EPA 1991
Scenario 2 - Construction Exposure: Future Use				
Exposure Frequency (days/year)	1-365	250	Based on an estimate of the number of workdays in one year.	EPA 1991
Ingestion Of Chemicals In Soils				
Ingestion Rate (mg/day)	0-480	480	Soil ingestion rate for construction work.	EPA 1991
Inhalation Of Airborne Chemicals Absorbed to Dust				
Inhalation Rate (m3/day)		14.4	Adults during moderate exertion (1.8 m3/hr, 8hr/day)	EPA 1991
Scenario 3 - Industrial Exposure: Future Use				
Exposure Frequency (days/year)	1-365	250	Based on an estimate of the number of workdays in one year.	EPA 1991
Ingestion Of Chemicals In Drinking Water				
Ingestion Rate (L/day)		1	Water ingestion rate for a commercial setting.	EPA 1991
Ingestion Of Chemicals in Soils				
Ingestion Rate (mg/day)	0-480	60	Soil ingestion rate for a commercial setting	EPA 1991
Scenario 4 - Residential Scenario: Future Use				
Exposure Frequency (days/yr)	1-365	350	Two weeks spent away from home.	EPA 1991
Ingestion Of Chemicals In Soils and House Dust				
Ingestion Rate (mg/day)				
Child	0-200	200	Children, 1-6 years old	EPA 1991
Adult	0-100	100	Age groups greater than 6 years old	EPA 1991
Ingestion Of Chemicals In Drinking Water				
Ingestion Rate (L/day)				
Child		0.750	Children, 0-6 years old	EPA 1990
Adult		2	Adult, 90th percentile	EPA 1989
Inhalation Of Airborne (Vapor Phase) Chemicals				
Inhalation Rate (m3/hr)		0.625	Adults and children, light activity assumed	EPA 1991
Exposure Time (hrs/day)	0-24	0.1 hr	Based upon the duration of a shower.	EPA 1989
Inhalation Of Airborne Chemicals Absorbed to Dust				
Inhalation Rate (m3/day)		20	Adults and children, light activity assumed.	EPA 1991

TABLE 3-6
SCENARIO 1
SUMMARY OF CANCER RISK ESTIMATES
MELVILLE NORTH LANDFILL

	TOTAL PATHWAY RISK	TOTAL PATHWAY RISK	
	4.8E-10	6.2E-07	MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	4.2E-10	3.3E-08	MEAN
	6.2E-07	MAXIMUM	
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	3.3E-08	MEAN	

TABLE 3-7
SCENARIO 1
SUMMARY OF CHRONIC HAZARD INDEX RATIOS
MELVILLE NORTH LANDFILL

	TOTAL PATHWAY RISK	TOTAL PATHWAY RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	2.7E-05	1.7E-03	MAXIMUM
	2.3E-06	2.3E-04	MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	1.7E-03	MAXIMUM	
	2.3E-04	MEAN	

TABLE 3-8
SCENARIO 2
SUMMARY OF CANCER RISK ESTIMATES
MELVILLE NORTH LANDFILL

	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK	
	7.4E-07	3.5E-05	MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.3E-08	2.8E-06	MEAN
	3.4E-05		MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.8E-06		MEAN
	3.7E-08		MAXIMUM
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	3.9E-09		MEAN

Compound Name	Chronic Daily Intake (CDI) - Mean (mg/kg/day)	Chronic Daily Intake (CDI) - Max (mg/kg/day)	CDI Adjusted for Absorption	RfD (mg/kg/day)	Confidence Level	Critical Effect	RfD Source/Basis	RfD Uncertainty Adjustments	Modifying Factors	Hazard Quotient Mean	Hazard Quotient Max	Pathway Hazard Index (HI)	Total Hazard Index (HI)
Exposure Pathway: Dermal Contact with Chemicals in Soil												2.1E-03	2.6E+01 MAXIMUM
												3.2E-04	3.6E-01 MEAN
Exposure Pathway: Ingestion of Chemicals in Soil												2.6E+01	MAXIMUM
												3.4E-01	MEAN
Inorganics													
Antimony	8.9E-05	8.5E-03	No	4E-04		Longevity, blood chemistry	Water/HEAST	1000	1	2.2E-01	2.1E+01		
Copper	1.1E-03	1.1E-01	No	4E-02		Local GI irritation	HEAST			2.7E-02	2.9E+00		
Exposure Pathway: Inhalation of Chemicals Absorbed to Dust												1.2E-03	MAXIMUM
												2.6E-05	MEAN

TABLE 3-10
SCENARIO 3
SUMMARY OF CANCER RISK ESTIMATES
MELVILLE NORTH LANDFILL

COMPOUND NAME	CHRONIC DAILY INTAKE(CDI)-MEAN (mg/kg/day)	CHRONIC DAILY INTAKE(CDI)-MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL SPECIFIC RISK-MEAN	CHEMICAL SPECIFIC RISK-MAX	TOTAL PATHWAY RISK	TOTAL RISK	
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL										4.1E-08	2.6E-04	MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL										3.8E-08	1.7E-04	MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER										8.1E-05	MAXIMUM	
INORGANICS										6.7E-08	MEAN	
Arsenic	3.01E-05	4.65E-05	No	1.75E+00	A	Skin	Water/IRIS	5.3E-05	8.1E-05			
Beryllium	5.17E-06	5.94E-06	No	4.30E+00	B2	Gross tumors, all sites	Water/IRIS	2.2E-05	2.6E-05			
VOLATILES												
1,1-Dichloroethene	2.41E-05	1.75E-05	No	6.00E-01	C	Adrenal pheochromocytoma	Oral/IRIS	1.4E-05	1.0E-05			
Trichloroethene	2.41E-05	1.75E-05	No	1.10E-02	B2	Liver	Gavage/HEAST	4.6E-05	3.3E-05			

TABLE 3-11
SCENARIO 3
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
MELVILLE NORTH LANDFILL

COMPOUND NAME	CHRONIC DAILY INTAKE (CDI) - MEAN (mg/kg/day)	CHRONIC DAILY INTAKE (CDI) - MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT MEAN	HAZARD QUOTIENT MAX	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL												9.0E-04	2.5E+00
												6.3E-05	1.6E+00
												1.5E-01	MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL												2.0E-02	MEAN
												2.4E+00	MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER												1.6E+00	MEAN
INORGANICS													
Thallium	3.91E-05	3.91E-05	No	7E-05		Alopecia, inc. SGOT, LDH levels	Diet/HEAST	3000	1	5.6E-01	5.6E-01		
Manganese	5.94E-04	1.99E-03	No	7E-03		No adverse effects	Water/HEAST	100	1	8.5E-02	2.8E-01		
Zinc	7.64E-03	4.08E-02	No	2E-01		Anemia	Therapeutic/HEAST	10	1	3.6E-02	2.0E-01		

TABLE 3-12
SCENARIO 4
SUMMARY OF CANCER RISK ESTIMATES
MELVILLE NORTH LANDFILL

COMPOUND NAME	CDI- CHILD MEAN (mg/kg/day)	CDI- ADULT MEAN (mg/kg/day)	CDI- CHILD MAX (mg/kg/day)	CDI- ADULT MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEM SPEC RISK- CHILD MEAN	CHEM SPEC RISK- ADULT MEAN	CHEM SPEC RISK- CHILD MAX	CHEM SPEC RISK- ADULT MAX	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK		
															2.8E-04	3.4E-04	CHILD- MEAN
															7.2E-04	7.7E-04	ADULT- MEAN
															2.8E-04	9.4E-04	CHILD- MAX
															7.1E-04	1.0E-03	ADULT- MAX
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER																	
INORGANICS																	
Arsenic	3.7E-05	1.0E-04	5.7E-05	1.6E-04	No	1.75E+00	A	Skin	Water/IRIS	6.4E-06	1.8E-04	1.0E-04	2.7E-04				
VOLATILES																	
Vinyl chloride	5.9E-05	1.6E-04	4.3E-05	1.2E-04	No	1.90E+00	A	Lung	Dust/HEAST	1.1E-04	3.1E-04	8.1E-05	2.2E-04				
															6.1E-08		CHILD- MEAN
															6.4E-08		ADULT- MEAN
															6.8E-08		CHILD- MAX
															1.3E-07		ADULT- MAX
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL																	
															6.4E-05		CHILD- MEAN
															2.2E-05		ADULT- MEAN
															6.8E-04		CHILD- MAX
															2.7E-04		ADULT- MAX
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																	
INORGANICS																	
Arsenic	6.5E-06	2.7E-06	2.7E-05	1.1E-05	No	1.75E+00	A	Skin	Water/IRIS	1.1E-05	4.7E-06	4.7E-06	1.9E-05				
SEMIVOLATILES																	
Benzo(a)anthracene	5.0E-07	2.1E-07	1.1E-05	4.8E-06	No	1.15E+01	B2	Liver, lung, skin	IRIS	5.7E-06	2.4E-06	1.3E-04	5.3E-05				
Benzo(b)pyrene	5.1E-07	2.1E-07	8.5E-06	3.5E-06	No	1.15E+01	B2	Lung, stomach	IRIS	5.9E-06	2.4E-06	9.8E-05	4.1E-05				
Benzo(k)fluoranthene	5.4E-07	2.2E-07	7.3E-06	3.0E-06	No	1.15E+01	B2	Lung, thosax, skin	IRIS	6.2E-06	2.6E-06	8.3E-05	3.5E-05				
Benzo(k)fluoranthene	5.1E-07	2.1E-07	7.7E-06	3.2E-06	No	1.15E+01	B2	Lung, thosax, skin	IRIS	5.9E-06	2.5E-06	8.9E-05	3.7E-05				
Chrysene	5.7E-07	2.4E-07	1.2E-05	5.2E-06	No	1.15E+01	B2	Malignant lymphoma	IRIS	6.6E-06	2.7E-06	1.4E-04	5.9E-05				
															2.2E-05		CHILD- MEAN
															2.3E-05		ADULT- MEAN
															1.8E-05		CHILD- MAX
															1.9E-05		ADULT- MAX
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																	
															3.0E-08		CHILD- MEAN
															3.1E-08		ADULT- MEAN
															1.0E-07		CHILD- MAX
															1.1E-08		ADULT- MAX
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																	
															1.1E-08		ADULT- MAX

TABLE 3-13
SCENARIO 4[illegible]

TABLE 3-14
SUMMARY OF EXPOSURE PATHWAYS
MELVILLE NORTH LANDFILL

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Inclusion
Current Land Use			
Children	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Children	Ingestion of soils on site	Yes	Access to site unrestricted
Children	Ingestion of sediments on site	No	Soils data Includes contamination near shore
Children	Ingestion of surface water on site	No	Data not available
Children	Dermal contact with soils	Yes	Access to site unrestricted
Children	Dermal contact with sediments	No	Soils data Includes contamination near shore
Children	Inhalation of fugitive dusts	No	Site vegetated
Children	Dermal contact with surface water	No	Data not available
Future Land Use			
Residents	Ingestion of ground water from local wells on the site	Yes	Potential residential use of site
Residents	Ingestion of soils on site	Yes	Potential residential use of site
Residents	Ingestion of sediments on site	No	Soils data Includes contamination near shore
Residents	Ingestion of surface water on site	No	Contact route unlikely; ground water available for ingestion
Residents	Dermal contact with soils	Yes	Potential residential use of site
Residents	Dermal contact with sediments	No	Soils data Includes contamination near shore
Residents	Inhalation of fugitive dusts	Yes	Potential residential use of site may produce areas devoid of cover
Residents	Inhalation of chemicals volatilized from ground water during home use	Yes	Potential residential use of site; volatile organics in ground water
Construction Workers	Ingestion of ground water from local wells	No	Wells not developed during construction
Construction Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Construction Workers	Ingestion of sediments on site	No	Soils data Includes contamination near shore
Construction Workers	Ingestion of surface water on site	No	Contact route unlikely
Construction Workers	Dermal contact with soils	Yes	Contact with soils expected during construction
Construction Workers	Dermal contact with sediments	No	Contact route unlikely
Construction Workers	Inhalation of fugitive dusts	Yes	Generation of fugitive dust expected during construction
Marina Employees	Ingestion of ground water from local wells	Yes	Potable supply from ground water
Marina Employees	Ingestion of soils on site	Yes	Incidental ingestion expected
Marina Employees	Ingestion of sediments on site	No	Soils data Includes contamination near shore
Marina Employees	Ingestion of surface water on site	No	Contact route unlikely
Marina Employees	Dermal contact with soils	Yes	Contact with soils may occur during work hours
Marina Employees	Dermal contact with sediments	No	Contact route unlikely
Marina Employees	Inhalation of fugitive dusts	No	Generation of fugitive dust not expected (Site vegetated or paved)

TABLE 4-1
SUMMARY OF SURFACE SOIL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
INORGANICS							
Aluminum	6/6	(0.2)a	5070-10600	8007.3	10600	33000	7000-100000
Arsimony	1/6	4.7-5.5	5.6	2.9	5.6	0.52	<1-8.8
Arsenic	6/6	(0.01)a	2-8.9	5.1	8.9	4.8	0.1-73
Barium	6/6	(0.2)a	5-28.3	19.3	28.3	290	10-1500
Beryllium	4/6	0.21-0.22	0.36-0.48	0.3	0.48	0.55	1-7
Cadmium	1/6	0.62-0.75	0.94	0.4	0.94	0.26 c	NA
Calcium	6/6	(5)a	540-21000	1689.2	21000	3400	100-280000
Chromium	6/6	(0.01)a	6.8-18.8	13.0	18.8	33	1-1000
Cobalt	6/6	(0.05)a	4.7-20	8.0	20	5.9	0.3-70
Copper	6/6	(0.025)a	11.2-44.3	20.8	44.3	13	1-700
Cyanide	0/6	(0.01)a	ND	NA	NA	NA	NA
Iron	6/6	(0.1)a	10100-35600	15976.8	35600	14000	100-100000
Lead	5/6	12.4	19-77.8	25.6	77.8	14	10-300
Magnesium	6/6	(5)a	917-7340	2275.9	7340	2100	50-50000
Manganese	6/6	(0.015)a	174-750	253.0	750	280	2-7000
Mercury	1/6	0.12-0.14	0.17	0.1	0.17	0.081	0.01-3.4
Nickel	6/6	(0.04)a	5.4-25.6	10.9	25.6	11	5-700
Potassium	6/6	(5)a	229-503	334.1	503	12000	50-37000
Selenium	1/6	0.37-0.49	0.53	0.3	0.53	0.3	0.1-3.9
Silver	1/6	0.62-0.75	0.68	0.4	0.68	NA	NA
Sodium	2/6	47.8-83.6	49-807	84.1	807	2500	500-50000
Thallium	1/6	0.63-0.99	0.74	0.5	0.74	7.7	2.2-23
Vanadium	6/6	(0.05)a	9.8-36.3	21.2	36.3	43	7-300
Zinc	6/6	(0.01)a	26.2-142	53.5	142	40	5-2900
VOLATILES							
1,1-Dichloroethane	0/6	0.006	ND	NA	NA	NA	NA
1,1-Dichloroethene	0/6	0.006	ND	NA	NA	NA	NA
1,1,1-Trichloroethane	0/6	0.006	ND	NA	NA	NA	NA
1,1,2-Trichloroethane	0/6	0.006	ND	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	0/6	0.006	ND	NA	NA	NA	NA
1,2-Dichloroethane	0/6	0.006	ND	NA	NA	NA	NA
1,2-Dichloroethene	0/6	0.006	ND	NA	NA	NA	NA
1,2-Dichloropropane	0/6	0.006	ND	NA	NA	NA	NA
1,3-Dichloropropane (cis)	0/6	0.006	ND	NA	NA	NA	NA
1,3-Dichloropropane (trans)	0/6	0.006	ND	NA	NA	NA	NA
2-Butanone	0/6	(0.01)a	ND	NA	NA	NA	NA
2-Hexanone	0/6	0.012	ND	NA	NA	NA	NA
4-Methyl-2-Pentanone	0/6	0.012	ND	NA	NA	NA	NA
Acetone	0/6	0.011-0.012	ND	NA	NA	NA	NA
Benzene	0/6	0.006	ND	NA	NA	NA	NA
Bromodichloromethane	0/6	0.006	ND	NA	NA	NA	NA
Bromoform	0/6	0.006	ND	NA	NA	NA	NA
Bromomethane	0/6	0.012	ND	NA	NA	NA	NA
Carbon disulfide	0/6	0.006	ND	NA	NA	NA	NA
Carbon Tetrachloride	0/6	0.006	ND	NA	NA	NA	NA
Chlorobenzene	0/6	0.006	ND	NA	NA	NA	NA
Chloroethane	0/6	0.012	ND	NA	NA	NA	NA
Chloroform	0/6	0.006	ND	NA	NA	NA	NA
Chloromethane	5/6	0.012	0.012	0.010	0.012	NA	NA
Dibromochloromethane	0/6	0.006	ND	NA	NA	NA	NA
Ethylbenzene	0/6	0.006	ND	NA	NA	NA	NA
Methylene chloride	0/6	10-14	ND	NA	NA	NA	NA
Styrene	0/6	0.006	ND	NA	NA	NA	NA
Tetrachloroethene	1/6	0.006	0.002	0.003	0.002	NA	NA
Toluene	0/6	0.006	ND	NA	NA	NA	NA
Trichloroethane	0/6	0.006	ND	NA	NA	NA	NA
Vinyl acetate	0/6	0.012	ND	NA	NA	NA	NA
Vinyl chloride	0/6	0.012	ND	NA	NA	NA	NA
Xylenes	0/6	0.006	ND	NA	NA	NA	NA

a SQLs in parenthesis are the contract required quantitation limits (CQRL)

b U.S. background range and average concentration are from (USGS, 1984)

c Average U.S. background (Carey, 1979)

NA Not Applicable

ND Non Detected

TABLE 4-1 (cont.)
SUMMARY OF SURFACE SOIL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg)b	RANGE OF U.S. BACKGROUND (mg/kg)b
SEMIVOLATILES							
1,2-Dichlorobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
1,2,4-Trichlorobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
1,3-Dichlorobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
1,4-Dichlorobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2-Chloronaphthalene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2-Chlorophenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2-Methylnaphthalene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2-Methylphenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2-Nitroaniline	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
2-Nitrophenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2,4-Dichlorophenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2,4-Dimethylphenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2,4-Dinitrophenol	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
2,4-Dinitrotoluene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2,4,5-Trichlorophenol	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
2,4,6-Trichlorophenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
2,6-Dinitrotoluene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
3-Nitroaniline	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
3,5-Dichlorobenzidine	2/6	0.82-4.3	1	0.762	1	NA	NA
4-Bromophenyl-phenylether	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
4-Chloro-3-methylphenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
4-Chloroaniline	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
4-Chlorophenyl-phenylether	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
4-Methylphenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
4-Nitroaniline	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
4-Nitrophenol	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
4,6-Dinitro-2-methylphenol	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
Acenaphthene	3/6	0.41-0.51	0.5-0.52	0.377	0.94	NA	NA
Acenaphthylene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Anthracene	3/6	0.41-0.51	0.5-1.5	0.363	1.5	NA	NA
Benzoic acid	4/6	2.2-11	2.0-2.6	2.411	2.6	NA	NA
Benzo(a)anthracene	6/6	(0.33)a	0.13-3.3	0.452	3.3	NA	NA
Benzo(a)pyrene	6/6	0.51	0.12-2.7	0.376	2.7	NA	NA
Benzo(b)fluoranthene	6/6	(0.33)a	0.12-2.8	0.424	2.8	NA	NA
Benzo(ghi)perylene	2/6	0.41-2.1	0.5-5.2	0.384	0.52	NA	NA
Benzo(k)fluoranthene	5/6	0.51	0.091-3.1	0.367	3.1	NA	NA
Benzyl Alcohol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Bis(2-chloroethoxy)methane	0/6	0.41-2.1	NA	NA	NA	NA	NA
Bis(2-chloroethyl)ether	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Bis(2-chloroisopropyl)ether	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Bis(2-ethylhexyl)phthalate	2/6	0.22-2.1	0.5-0.59	0.331	0.59	NA	NA
Butylbenzylphthalate	2/6	0.41-2.1	0.5-0.59	0.384	0.52	NA	NA
Chrysene	6/6	(33)a	0.11-2.8	0.437	2.8	NA	NA
Dibenzofuran	3/6	0.41-0.51	0.5-0.86	0.366	0.86	NA	NA
Dibenzo(a,h)anthracene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Diethylphthalate	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Dimethylphthalate	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Di-n-butylphthalate	3/6	0.41-2.1	0.5-0.52	0.431	0.52	NA	NA
Di-n-octylphthalate	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Fluoranthene	6/6	(0.33)a	0.073-8	0.367	8	NA	NA
Fluorene	3/6	0.41-0.51	0.5-1.2	0.393	1.2	NA	NA
Hexachlorobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Hexachlorobutadiene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Hexachlorocyclopentadiene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Hexachloroethane	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Indeno(1,2,3-cd)pyrene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Isophorone	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Naphthalene	2/6	0.41-0.51	0.48-0.52	0.337	0.52	NA	NA
Nitrobenzene	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
N-Nitroso-dl-n-propylamine	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
N-Nitrosodiphenylamine	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Pentachlorophenol	2/6	2-11	2.5-2.6	1.914	2.6	NA	NA
Phenanthrene	6/6	(0.33)a	0.083-7.2	0.435	7.2	NA	NA
Phenol	2/6	0.41-2.1	0.5-0.52	0.384	0.52	NA	NA
Pyrene	6/6	(0.33)a	0.1-5.7	0.433	5.7	NA	NA
PESTICIDES							
4,4'-DDD	0/6	0.0088-0.011	ND	NA	NA	NA	NA
4,4'-DDE	5/6	0.018	0.029-0.081	0.006	0.0081	NA	NA
4,4'-DDT	5/6	0.0088	0.023-0.088	0.006	0.0088	NA	NA
Aldrin	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Alpha-BHC	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Alpha-Chlordane	0/6	0.088-0.11	ND	NA	NA	NA	NA
Beta-BHC	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Gamma-Chlordane	0/6	0.088-0.11	ND	NA	NA	NA	NA
Delrin	0/6	0.018-0.022	ND	NA	NA	NA	NA
Delta-BHC	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Endosulfan I	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Endosulfan II	0/6	0.018-0.022	ND	NA	NA	NA	NA
Endosulfan Sulfate	0/6	0.018-0.022	ND	NA	NA	NA	NA
Endrin	0/6	0.018-0.022	ND	NA	NA	NA	NA
Endrin ketone	0/6	0.018-0.022	ND	NA	NA	NA	NA
Gamma-BHC	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Heptachlor	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Heptachlor epoxide	0/6	0.0088-0.011	ND	NA	NA	NA	NA
Methoxychlor	0/6	0.088-0.11	ND	NA	NA	NA	NA
Toxaphene	0/6	0.18-0.22	ND	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/6	0.088-0.11	ND	NA	NA	NA	NA
Aroclor-1221	0/6	0.088-0.11	ND	NA	NA	NA	NA
Aroclor-1232	0/6	0.088-0.11	ND	NA	NA	NA	NA
Aroclor-1242	0/6	0.088-0.11	ND	NA	NA	NA	NA
Aroclor-1248	0/6	0.088-0.11	ND	NA	NA	NA	NA
Aroclor-1254	1/6	0.18-0.22	08	0.096	0.08	NA	NA
Aroclor-1260	0/6	0.18-0.22	ND	NA	NA	NA	NA

a SQLs in parenthesis are the contract required quantitation limits (CQL)
b U.S. background range and average concentration are from (USGS, 1984)
c Average U.S. background (Carey, 1979)
NA Not Applicable
ND Non Detected

TABLE 4-2
SUMMARY OF SUBSURFACE SOIL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SOL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
INORGANICS							
Aluminum	15/15	(0.2)a	3210-11900	6775.48	11900.00	33000	7000-100000
Antimony	7/15	3.6-9.5	3.9-5.5	3.80	5.50	0.52	<1-8.8
Arsenic	15/15	(0.01)a	1.3-9.6	3.96	9.60	4.8	0.1-7.3
Barium	15/15	(0.2)a	4.9-57.5	14.60	57.50	290	10-1500
Beryllium	13/15	0.18-0.22	0.17-0.35	0.20	0.35	0.55	1-7
Cadmium	6/15	0.49-0.74	0.56-8.1	0.48	8.10	0.26 c	NA
Calcium	15/15	(5)a	523-91300	2007.25	91300.00	3400	100-280000
Chromium	15/15	(0.01)a	5.4-15.2	9.85	15.20	33	1-1000
Cobalt	15/15	(0.05)a	2.8-20.5	9.57	20.50	5.9	0.3-70
Copper	14/15	12	6.1-312	28.29	312.00	13	1-700
Cyanide	0/15	(0.01)a	NA	NA	NA	NA	NA
Iron	15/15	(0.1)a	5230-38200	18873.58	38200.00	14000	100-100000
Lead	15/15	(0.005)a	0.64-777	28.57	777.00	14	10-300
Magnesium	15/15	(0.015)a	602-4010	2385.52	4010.00	2100	50-50000
Manganese	15/15	(0.0002)a	70.7-980	298.98	980.00	280	2-7000
Mercury	2/15	0.11-0.14	0.16-0.21	0.07	0.21	0.081	0.01-3.4
Nickel	15/15	(0.04)a	5.6-28.8	14.91	28.80	11	5-700
Potassium	15/15	(5)a	210-000	378.87	901.00	12000	50-37000
Selenium	9/15	0.33-0.69	0.31-1.7	0.37	1.70	0.3	0.1-3.9
Silver	5/15	0.49-2.4	0.53-0.63	0.42	0.63	NA	NA
Sodium	12/15	44.4-67.4	56.6-3820	182.88	3820.00	2500	500-50000
Thallium	13/15	(0.01)a	0.59-8.1	0.89	8.10	7.7	2.2-23
Vanadium	15/15	(0.06)a	8.3-22.1	15.70	22.10	43	7-300
Zinc	13/15	39.4-52.3	23.6-2580	88.95	2580.00	40	5-2900
VOLATILES							
1,1-Dichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,1-Dichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,1,1-Trichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,1,2-Trichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,1,2,2-Tetrachloroethane	2/17	0.005-1.8	0.005-0.007	0.0082	0.0070	NA	NA
1,2-Dichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,2-Dichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,2-Dichloropropane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,3-Dichloropropene (cis)	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
1,3-Dichloropropene (trans)	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
2-Butanone	2/17	0.012	1-11	0.0871	1.1000	NA	NA
2-Hexanone	4/17	0.01-3.7	0.011-0.014	0.0178	0.0140	NA	NA
4-Methyl-2-Pentanone	2/17	0.01-3.7	0.011-0.014	0.0164	0.0140	NA	NA
Acetone	1/17	0.009-3.0	3.7	0.0338	3.7000	NA	NA
Benzene	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Bromodichloromethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Bromoforn	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Bromomethane	1/17	0.01-3.7	0.011	0.0158	0.0110	NA	NA
Carbon disulfide	3/17	0.005-1.8	0.003-0.011	0.0085	0.0110	NA	NA
Carbon Tetrachloride	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Chlorobenzene	2/17	0.005-1.8	0.005-0.007	0.0082	0.0070	NA	NA
Chloroethane	1/17	0.01-3.7	0.011	0.0158	0.0110	NA	NA
Chloroform	2/17	0.005-1.8	0.005-0.008	0.0082	0.0080	NA	NA
Chloromethane	4/17	0.01-3.7	0.011-0.014	0.0178	0.0140	NA	NA
Dibromochloromethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Ethylbenzene	4/17	0.005-1.8	0.005-0.18	0.0100	0.1800	NA	NA
Methylene chloride	0/17	0.01-2.0	NA	NA	NA	NA	NA
Styrene	2/17	0.005-1.8	0.005-0.007	0.0082	0.0070	NA	NA
Tetrachloroethane	2/17	0.005-1.8	0.005-0.007	0.0082	0.0070	NA	NA
Toluene	3/17	0.005-1.8	0.001-0.067	0.0079	0.0670	NA	NA
Trichloroethane	1/17	0.005-1.8	0.005	0.0079	0.0050	NA	NA
Vinyl acetate	2/17	0.01-3.7	0.012-0.014	0.0171	0.0000	NA	NA
Vinyl chloride	1/17	0.01-3.7	0.011	0.0158	0.0110	NA	NA
Xylenes	4/17	0.005-1.8	0.005-1.2	0.0101	1.2000	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
b. U.S. background range and average concentration are from (USGS, 1984)
c. Average U.S. background (Carey, 1979)
NA Not Applicable
ND Non Detected

TABLE 4-2 (cont.)
SUMMARY OF SUBSURFACE SOIL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
SEMIVOLATILES							
1,2-Dichlorobenzene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
1,2,4-Trichlorobenzene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
1,3-Dichlorobenzene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
1,4-Dichlorobenzene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2-Chloronaphthalene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2-Chlorophenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2-Methylnaphthalene	4/17	0.39-8.6	0.068-0.67	0.290	0.670	NA	NA
2-Methylphenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2-Nitroaniline	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
2-Nitrophenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2,4-Dichlorophenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2,4-Dimethylphenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2,4-Dinitrophenol	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
2,4-Dinitrotoluene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2,4,5-Trichlorophenol	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
2,4,6-Trichlorophenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
2,6-Dinitrotoluene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
3-Nitroaniline	5/17	1.9-43	2-2.5	1.679	2.500	NA	NA
3,3'-Dichlorobenzidine	5/17	0.78-17	0.78-0.99	0.678	0.990	NA	NA
4-Bromophenyl-phenylether	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
4-Chloro-3-methylphenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
4-Chloroaniline	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
4-Chlorophenyl-phenylether	0/17	0.39-8.6	ND	NA	NA	NA	NA
4-Methylphenol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
4-Nitroaniline	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
4-Nitrophenol	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
4,6-Dinitro-2-methylphenol	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
Acenaphthene	6/17	0.39-8.6	0.13-1.6	0.329	1.600	NA	NA
Acenaphthylene	3/17	0.39-8.6	0.054-0.46	0.276	0.460	NA	NA
Anthracene	11/17	0.39-8.6	0.066-1.1	0.260	1.100	NA	NA
Benzoic acid	4/17	1.9-43	0.2-2.3	1.404	2.300	NA	NA
Benzo(a)anthracene	11/17	0.012-0.49	0.089-1.8	0.304	1.800	NA	NA
Benzo(a)pyrene	12/17	0.39-0.47	0.084-1.6	0.310	1.600	NA	NA
Benzo(b)fluoranthene	12/17	0.39-0.47	0.063-1.4	0.302	1.400	NA	NA
Benzo(ghi)perylene	8/17	0.39-8.6	0.075-0.74	0.309	0.740	NA	NA
Benzo(k)fluoranthene	12/17	0.39-0.47	0.062-1.4	0.246	1.400	NA	NA
Benzyl Alcohol	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Bis(2-chloroethoxy)methane	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Bis(2-chloroethyl)ether	5/17	0.39-8.6	0.39-0.49	0.329	0.490	NA	NA
Bis(2-chloroisopropyl)ether	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Bis(2-ethylhexyl)phthalate	1/17	0.39-8.6	0.43	0.276	0.430	NA	NA
Butylbenzylphthalate	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Chrysene	11/17	0.012-0.49	0.076-1.7	0.284	1.700	NA	NA
Dibenzofuran	4/17	0.39-8.6	0.17-0.46	0.295	0.460	NA	NA
Dibenzo(a,h)anthracene	6/17	0.39-8.6	0.06-0.46	0.250	0.460	NA	NA
Diethylphthalate	0/17	0.39-8.6	NA	NA	NA	NA	NA
Dimethylphthalate	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Di-n-butylphthalate	2/17	0.063-8.6	0.43-0.46	0.246	0.460	NA	NA
Di-n-octylphthalate	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Fluoranthene	14/17	0.39-0.41	0.088-3.7	0.457	2.400	NA	NA
Fluorene	5/17	0.39-8.6	0.2-0.73	0.317	0.730	NA	NA
Hexachlorobenzene	2/17	0.39-8.6	0.43-0.46	0.300	0.460	NA	NA
Hexachlorobutadiene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Hexachlorocyclopentadiene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Hexachloroethane	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Indeno(123cd)pyrene	9/17	0.39-8.6	0.071-0.62	0.309	0.620	NA	NA
Isophorone	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Naphthalene	3/17	0.39-8.6	0.076-0.43	0.260	0.430	NA	NA
Nitrobenzene	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
N-Nitroso-d-n-propylamine	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
N-Nitrosodiphenylamine	2/17	0.39-8.6	0.43-0.46	0.299	0.460	NA	NA
Pentachlorophenol	2/17	1.9-43	2.1-2.3	1.486	2.300	NA	NA
Phenanthrene	14/17	0.39-0.45	0.057-4.6	0.436	4.600	NA	NA
Phenol	5/17	0.39-8.6	0.045-0.49	0.292	0.490	NA	NA
Pyrene	16/17	0.41	0.072-4.9	0.426	4.900	NA	NA
PESTICIDES							
1,4,4'-DDD	0/17	0.017-0.035	NA	NA	NA	NA	NA
1,4,4'-DDE	0/17	0.017-0.035	NA	NA	NA	NA	NA
1,4,4'-DDT	0/17	0.017-0.035	NA	NA	NA	NA	NA
Aldrin	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Alpha-BHC	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Alpha-chlordane	0/17	0.084-0.17	NA	NA	NA	NA	NA
Beta-BHC	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Dieldrin	0/17	0.017-0.035	NA	NA	NA	NA	NA
Delta-BHC	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Endosulfan I	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Endosulfan II	0/17	0.017-0.035	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/17	0.017-0.035	NA	NA	NA	NA	NA
Endrin	0/17	0.017-0.035	NA	NA	NA	NA	NA
Endrin ketone	0/17	0.017-0.035	NA	NA	NA	NA	NA
Gamma-BHC	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Gamma-chlordane	0/17	0.084-0.17	NA	NA	NA	NA	NA
Heptachlor	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Heptachlor epoxide	0/17	0.0084-0.017	NA	NA	NA	NA	NA
Methoxychlor	0/17	0.084-0.17	NA	NA	NA	NA	NA
Toxaphene	0/17	0.17-0.35	NA	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/17	0.084-0.17	NA	NA	NA	NA	NA
Aroclor-1221	0/17	0.084-0.17	NA	NA	NA	NA	NA
Aroclor-1232	0/17	0.084-0.17	NA	NA	NA	NA	NA
Aroclor-1242	0/17	0.084-0.17	NA	NA	NA	NA	NA
Aroclor-1248	0/17	0.084-0.17	NA	NA	NA	NA	NA
Aroclor-1254	0/17	0.17-0.35	NA	NA	NA	NA	NA
Aroclor-1260	0/17	0.17-0.35	NA	NA	NA	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
b. U.S. background range and average concentration are from (USGS, 1984)
c. Average U.S. background (Carey, 1979)
NA Not Applicable
ND Non Detected

TABLE 4-3
SUMMARY OF MONITORING WELL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL µg/l	RANGE OF DETECTION µg/l	GEOMETRIC MEAN OF CONCENTRATION µg/l	MAXIMUM CONCENTRATION µg/l	ON SITE BACKGROUND LEVEL ^b µg/l
INORGANICS						
Aluminum	5/5	(200)a	1890 - 44600	12991	44600	14500
Antimony	0/5	22 0 - 25 0	NA	NA	NA	<22.0
Arsenic	5/5	(10 0)a	2 - 16 6	4.2	17	2.0
Barium	5/5	(200)a	39 9 - 569	101 3	569	50 1
Beryllium	1/5	1	2.4	0.7	2	<1 0
Cadmium	1/5	3	48 8	3.0	48	<3 0
Calcium	5/5	(5000)a	17900 - 189000	65347 1	189000	115000
Chromium	5/5	(10 0)a	5.4 - 47	22.7	47	20 1
Cobalt	4/5	19 5	21 1 - 50	26.2	50	26 5
Copper	4/5	10 8	31 8 - 1030	63.2	1030	31 8
Cyanide	1/5	10	23 3	6 8	23	<10 0
Iron	5/5	(100)a	5750 - 157000	46531 6	157000	41700
Lead	5/5	(5 0)a	11 7 - 4120	112 1	4120	11 7
Magnesium	5/5	(5000)a	5250 - 414000	41581 1	414000	40000
Manganese	5/5	(15 0)a	1410 - 6720	4453 0	6720	6140
Mercury	2/5	.2	1.3 - 2.1	0.3	2	<0.2
Nickel	2/5	38 1 - 57 3	51 5 - 61 5	39 1	62	<51 5
Potassium	5/5	(5000)a	3020 - 199000	16452 2	199000	8000
Selenium	0/5	2	NA	NA	NA	<2.0
Silver	0/5	3 - 10	NA	NA	NA	<3 3
Sodium	5/5	(5000)a	26700 - 280000C	178586 2	2800000	65600
Thallium	5/5	(10 0)a	4 - 40	15 9	40	40 0
Vanadium	0/5	12.5 - 76 2	NA	NA	NA	<33 7
Zinc	5/5	(20 0)a	108 - 12400	445 6	12400	130
VOLATILES						
1,1-Dichloroethane	2/5	5	5 - 25	4 6	25	<5
1,1-Dichloroethene	2/5	5	5 - 25	4 6	25	<5
1,1,1-Trichloroethane	2/5	5	5 - 25	4 6	25	<5
1,1,2-Trichloroethane	2/5	5	5 - 25	4 6	25	<5
1,1,2,2-Tetrachloroethane	2/5	5	5 - 25	4 6	25	<5
1,2-Dichloroethane	2/5	5	5 - 25	4 6	25	<5
1,2-Dichloroethene	2/5	5	5 - 25	4 6	25	<5
1,2-Dichloropropane	2/5	5	5 - 25	4 6	25	<5
1,3-Dichloropropene (cis)	2/5	5	5 - 25	4 6	25	<5
1,3-Dichloropropene (trans)	2/5	5	5 - 25	4 6	25	<5
2-Butanone	2/5	10	10 - 50	9 1	50	<10
2-Hexanone	2/5	10	10 - 50	9 1	50	<10
4-Methyl-2-Pentanone	2/5	10	10 - 50	9 1	50	<10
Acetone	0/5	10 - 100	NA	NA	NA	<10
Benzene	2/5	5	5 - 25	4 6	25	<5
Bromodichloromethane	2/5	5	5 - 25	4 6	25	<5
Bromoforn	2/5	5	5 - 25	4 6	25	<5
Bromomethane	2/5	10	10 - 50	9 1	50	<10
Carbon disulfide	2/5	5	5 - 25	4 6	25	<5
Carbon Tetrachloride	2/5	5	5 - 25	4 6	25	<5
Chlorobenzene	2/5	5	5 - 25	4 6	25	<5
Chloroethane	2/5	10	10 - 50	9 1	50	<10
Chloroform	3/5	5	2 - 25	4.4	25	<5
Chloromethane	2/5	10	10 - 50	9 1	50	<10
Dibromochloromethane	2/5	5	5 - 25	4 6	25	<5
Ethylbenzene	2/5	5	5 - 25	4 6	25	<5
Methylene chloride	0/5	11 - 80	NA	NA	NA	<15
Styrene	2/5	5	5 - 25	4 6	25	<5
Tetrachloroethene	2/5	5	5 - 25	4 6	25	<5
Toluene	2/5	5	5 - 25	4 6	25	<5
Trichloroethene	2/5	5	5 - 25	4 6	25	<5
Vinyl acetate	2/5	10	10 - 50	9 1	50	<10
Vinyl chloride	2/5	10	10 - 50	9 1	50	<10
Xylenes	2/5	5	5 - 25	4 6	25	<5

a Sample Quantitation Limits (SQLs) found in parenthesis are
Contract required Quantitation Limits (CQRLs)
b Background levels values from Monitoring well # 5

TABLE 4-3 (cont.)
SUMMARY OF MONITORING WELL DATA
FOR FIRE FIGHTING TRAINING SCHOOL

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL	RANGE OF DETECTION	GEOMETRIC MEAN OF CONCENTRATION	MAXIMUM CONCENTRATION	ON SITE BACKGROUND LEVEL
		μg/l	μg/l	μg/l	μg/l	μg/l
SEMI-VOLATILES						
1,2-Dichlorobenzene	1/5	10.0	10.0	5.7	10	<10
1,2,4-Trichlorobenzene	1/5	10.0	10.0	5.7	10	<10
1,3-Dichlorobenzene	1/5	10.0	10.0	5.7	10	<10
1,4-Dichlorobenzene	1/5	10.0	10.0	5.7	10	<10
2-Chloronaphthalene	2/5	10.0	10.0	7.8	10	<10
2-Chlorophenol	0/5	10.0	NA	NA	NA	<10
2-Methylnaphthalene	1/5	10.0	10.0	5.7	10	<10
2-Methylphenol	0/5	10.0	NA	NA	NA	<10
2-Nitroaniline	2/5	50.0	50.0	33.0	50	<50
2-Nitrophenol	0/5	10.0	NA	NA	NA	<10
2,4-Dichlorophenol	0/5	10.0	NA	NA	NA	<10
2,4-Dimethylphenol	0/5	10.0	NA	NA	NA	<10
2,4-Dinitrophenol	1/5	50.0	50.0	29.7	50	<50
2,4-Dinitrotoluene	2/5	10.0	10.0	6.6	10	<10
2,4,6-Trichlorophenol	1/5	50.0	50.0	29.7	50	<50
2,4,6-Trichlorophenol	1/5	10.0	10.0	5.9	10	<10
2,6-Dinitrotoluene	2/5	10.0	10.0	6.6	10	<10
3-Nitroaniline	2/5	50.0	50.0	33.0	50	<50
3,3'-Dichlorobenzidine	1/5	20.0	20.0	11.5	20	<20
4-Bromophenyl-phenylether	2/5	10.0	10.0	6.6	10	<10
4-Chloro-3-methylphenol	0/5	10.0	NA	NA	NA	<10
4-Chloroaniline	1/5	10.0	10.0	5.7	10	<10
4-Chlorophenyl-phenylether	2/5	10.0	10.0	7.8	10	<10
4-Methylphenol	0/5	10.0	NA	NA	NA	<10
4-Nitroaniline	2/5	50.0	50.0	33.0	50	<50
4-Nitrophenol	2/5	50.0	50.0	33.0	50	<50
4,6-Dinitro-2-methylphenol	1/5	50.0	50.0	29.7	50	<50
Acenaphthene	3/5	10.0	20-24.0	6.5	24	<10
Acenaphthylene	2/5	10.0	10.0	6.6	10	<10
Anthracene	2/5	10.0	90-100.0	6.5	10	<10
Benzoic acid	0/5	50.0	NA	NA	NA	<50
Benzo(a)anthracene	2/5	10.0	30-100.0	5.2	10	<10
Benzo(a)pyrene	2/5	10.0	20-100.0	4.6	10	<10
Benzo(b)fluoranthene	2/5	10.0	10-100.0	4.2	10	<10
Benzo(g,h,i)perylene	1/5	10.0	10.0	5.7	10	<10
Benzo(k)fluoranthene	1/5	10.0	10.0	5.7	10	<10
Benzyl Alcohol	1/5	10.0	10.0	5.7	10	<10
Bis(2-chloroethoxy)methane	1/5	10.0	10.0	5.7	10	<10
Bis(2-chloroethyl)ether	1/5	10.0	10.0	5.7	10	<10
Bis(2-chloroisopropyl)ether	1/5	10.0	10.0	5.7	10	<10
Bis(2-ethylhexyl)phthalate	1/5	10.0	10.0	5.9	10	<10
Butylbenzylphthalate	1/5	10.0	10.0	5.7	10	<10
Chrysene	2/5	10.0	40-100.0	5.5	10	<10
Dibenzofuran	3/5	10.0	10-100.0	4.8	10	<10
Dibenzo(a,h)anthracene	1/5	10.0	10	5.7	10	<10
Diethylphthalate	2/5	10.0	10	6.6	10	<10
Dimethylphthalate	2/5	10.0	10	6.6	10	<10
Di-n-butylphthalate	2/5	10.0	10	6.6	10	<10
Di-n-octylphthalate	1/5	10.0	10	5.7	10	<10
Fluoranthene	2/5	10.0	60-100.0	6.0	10	<10
Fluorene	3/5	10.0	10-21.0	7.7	21	<10
Hexachlorobenzene	2/5	10.0	10.0	6.6	10	<10
Hexachlorobutadiene	1/5	10.0	10.0	5.7	10	<10
Hexachlorocyclopentadiene	2/5	10.0	10.0	6.6	10	<10
Hexachloroethane	1/5	10.0	10.0	5.7	10	<10
Indeno(123cd)pyrene	1/5	10.0	10.0	5.7	10	<10
Isophorone	1/5	10.0	10.0	5.7	10	<10
Naphthalene	1/5	10.0	10.0	5.7	10	<10
Nitrobenzene	1/5	10.0	10.0	5.7	10	<10
N-Nitroso-di-n-propylamine	1/5	10.0	10.0	5.7	10	<10
N-Nitrosodiphenylamine	2/5	10.0	10.0	6.6	10	<10
Pentachlorophenol	1/5	50.0	50.0	29.7	50	<50
Phenanthrene	2/5	10.0	10.0-44.0	5.9	44	<10
Phenol	0/5	10.0	NA	NA	NA	<10
Pyrene	2/5	10.0	10.0-23.0	7.8	23	<10
PESTICIDES						
4,4'-DDD	0/5	0.1-0.5	NA	NA	NA	<0.10
4,4'-DDE	0/5	0.1-0.5	NA	NA	NA	<0.10
4,4'-DDT	0/5	0.1-0.5	NA	NA	NA	<0.10
Aldrin	0/5	0.05-0.25	NA	NA	NA	<0.05
Alpha-BHC	0/5	0.05-0.25	NA	NA	NA	<0.05
Alpha-Chlordane	0/5	0.5-2.5	NA	NA	NA	<0.5
Beta-BHC	0/5	0.05-0.25	NA	NA	NA	<0.05
Gamma-Chlordane	0/5	0.5-2.5	NA	NA	NA	<0.5
Dieldrin	0/5	0.1-0.5	NA	NA	NA	<0.10
Delta-BHC	0/5	0.05-0.25	NA	NA	NA	<0.05
Endosulfan I	0/5	0.05-0.25	NA	NA	NA	<0.05
Endosulfan II	0/5	0.1-0.5	NA	NA	NA	<0.10
Endosulfan Sulfate	0/5	0.1-0.5	NA	NA	NA	<0.10
Endrin	0/5	0.1-0.5	NA	NA	NA	<0.10
Endrin ketone	0/5	0.1-0.5	NA	NA	NA	<0.10
Gamma-BHC	0/5	0.05-0.25	NA	NA	NA	<0.05
Heptachlor	0/5	0.05-0.25	NA	NA	NA	<0.05
Heptachlor epoxide	0/5	0.05-0.25	NA	NA	NA	<0.05
Methoxychlor	0/5	0.5-2.5	NA	NA	NA	<0.5
Toxaphene	0/5	1.0-5.0	NA	NA	NA	<1.0
PCB's						
Aroclor-1016	0/5	0.5-2.5	NA	NA	NA	<0.5
Aroclor-1221	0/5	0.5-2.5	NA	NA	NA	<0.5
Aroclor-1232	0/5	0.5-2.5	NA	NA	NA	<0.5
Aroclor-1242	0/5	0.5-2.5	NA	NA	NA	<0.5
Aroclor-1248	0/5	0.5-2.5	NA	NA	NA	<0.5
Aroclor-1254	0/5	1.0-5.0	NA	NA	NA	<1.0
Aroclor-1260	0/5	1.0-5.0	NA	NA	NA	<1.0

a Sample Quantitation Limits (SQLs) found in parentheses are Contract required Quantitation Limits (CQRLs)

b Background levels values from Monitoring well # 5

TABLE 4-4
SUMMARY OF CONTAMINANTS
OLD FIREFIGHTING TRAINING SCHOOL

COMPOUND NAME		RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (µg/L)
INORGANICS				
Aluminum	&*	5070-10800	3210-11900	1890-44800
Antimony	&*	56	39-56	ND
Arsenic	&*	2-89	13-96	2-166
Barium	&*	8-283	49-576	399-569
Beryllium	&*	039-048	017-035	24
Cadmium	&*	094	056-81	488
Calcium		540-21000	523-91300	17900-189000
Chromium	&*	68-188	54-152	64-47
Cobalt	&*	47-20	28-205	211-50
Copper	&*	11.2-443	61-312	318-1030
Cyanide		ND	ND	233
Iron		10100-35800	5230-36200	5750-157000
Lead	&***	19-778	064-777	117-4120
Magnesium		917-7340	602-4010	5250-414000
Manganese	&*	174-750	707-980	1410-8720
Mercury	&*	017	016-021	13-21
Nickel	&*	54-256	58-288	515-815
Potassium		229-503	210-901	3020-199000
Selenium	&*	053	031-17	ND
Silver		068	X 053-063	ND
Sodium		49-907	566-3820	26700-2800000
Thallium		074	X 059-81	4-40
Vandium		96-363	83-221	ND
Zinc	&*	26.2-142	236-2580	108-12400
VOLATILE S				
1,1-Dichloroethane		ND	X 0005	X 5-25
1,1-Dichloroethane	&*	ND	X 0005	X 5-25
1,1,1-Trichloroethane		ND	X 0005	X 5-25
1,1,2-Trichloroethane		ND	X 0005	X 5-25
1,1,2,2-Tetrachloroethane	&	ND	X 0005-0007	X 5-25
1,2-Dichloroethane		ND	X 0005	X 5-25
1,2-Dichloroethane		ND	X 0005	X 5-25
1,2-Dichloropropene		ND	X 0005	X 5-25
1,3-Dichloropropene (cis)		ND	X 0005	X 5-25
1,3-Dichloropropene (trans)		ND	X 0005	X 5-25
2-Butanone		ND	1-11	X 10-50
2-Hexanone		ND	X 0011-0014	X 10-50
4-Methyl-2-Pentanone		ND	X 0011-0014	X 10-50
Acetone		ND	X 37	NA
Benzene	&	ND	X 0005	X 5-25
Bromodichloromethane		ND	X 0005	X 5-25
Bromoforn		ND	X 0005	X 5-25
Bromomethane		ND	X 0011	X 10-50
Carbon disulfide	&	ND	0003-0011	X 5-25
Carbon Tetrachloride		ND	X 0005	X 5-25
Chlorobenzene		ND	X 0005-0007	X 5-25
Chloroethane		ND	X 0011	X 10-50
Chloroform	&***	ND	X 0005-0008	2-25
Chloromethane	&*	X 0012	X 0011-0014	X 10-50
Dibromochloromethane		ND	X 0005	X 5-25
Ethylbenzene	&*	ND	0005-016	X 5-25
Methylene chloride		ND	ND	ND
Styrene	&*	ND	X 0005-0007	X 5-25
Tetrachloroethane	&*	0002	X 0005-0007	X 5-25
Toluene	&*	ND	0001-0067	X 5-25
Trichloroethane		ND	X 0005	X 5-25
Vinyl acetate		ND	0012-0014	X 10-50
Vinyl chloride	&*	ND	X 0011	X 10-50
Xylenes	&*	ND	0005-12	X 5-25

& Included as chemicals of potential concern for this site
 * Risk addressed quantitatively only
 ** Risk addressed qualitatively only
 *** Risk addressed both quantitatively and qualitatively
 X Values "UJ" qualified data only
 ND Not Detected

TABLE 4-4 (cont.)
SUMMARY OF CONTAMINANTS
OLD FIREFIGHTING TRAINING SCHOOL

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (µg/L)
SEMI-VOLATILES			
1,2-Dichlorobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
1,2,4-Trichlorobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
1,3-Dichlorobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
1,4-Dichlorobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
2-Chloronaphthalene	X 0.5-0.52	X 0.43-0.46	X 10.0
2-Chlorophenol	X 0.5-0.52	X 0.43-0.46	X ND
2-Methylnaphthalene	X 0.5-0.52	0.088-0.67	X 10.0
2-Methylphenol	X 0.5-0.52	X 0.43-0.46	X ND
2-Nitroaniline	X 2.5-2.6	X 2.1-2.3	X 50.0
2-Nitrophenol	X 0.5-0.52	X 0.43-0.46	X ND
2,4-Dichlorophenol	X 0.5-0.52	X 0.43-0.46	X ND
2,4-Dimethylphenol	X 0.5-0.52	X 0.43-0.46	X ND
2,4-Dinitrophenol	X 2.5-2.6	X 2.1-2.3	X 50.0
2,4-Dinitrotoluene	X 0.5-0.52	X 0.43-0.46	X 10.0
2,4,6-Trichlorophenol	X 2.5-2.6	X 2.1-2.3	X 50.0
2,4,6-Trichlorophenol	X 0.5-0.52	X 0.43-0.46	X 10.0
2,6-Dinitrotoluene	X 0.5-0.52	X 0.43-0.46	X 10.0
3-Nitroaniline	X 2.5-2.6	X 2-2.5	X 50.0
3,3'-Dichlorobenzidine	X 1	X 0.78-0.99	X 20.0
4-Bromophenyl-phenylether	X 0.5-0.52	X 0.43-0.46	X 10.0
4-Chloro-3-methylphenol	X 0.5-0.52	X 0.43-0.46	X ND
4-Chloroaniline	X 0.5-0.52	X 0.43-0.46	X 10.0
4-Chlorophenyl-phenylether	X 0.5-0.52	X ND	X 10.0
4-Methylphenol	X 0.5-0.52	X 0.43-0.46	X ND
4-Nitroaniline	X 2.5-2.6	X 2.1-2.3	X 50.0
4-Nitrophenol	X 2.5-2.6	X 2.1-2.3	X 50.0
4,6-Dinitro-2-methylphenol	X 2.5-2.6	X 2.1-2.3	X 50.0
Acenaphthene	&*** 0.5-0.94	0.13-1.6	2.0-24.0
Acenaphthylene	&*** X 0.5-0.52	0.054-0.48	X 10.0
Anthracene	&*** 0.5-1.5	0.086-1.1	9.0-10.0
Benzoic acid	X 2.0-2.6	0.2-2.3	X ND
Benzo(a)anthracene	&*** 0.13-3.3	0.089-1.8	3.0-10.0
Benzo(a)pyrene	&*** 0.12-2.7	0.084-1.6	2.0-10.0
Benzo(b)fluoranthene	&*** 0.12-2.8	0.083-1.4	1.0-10.0
Benzo(ghi)perylene	&*** X 0.5-52	0.076-0.74	X 10.0
Benzo(k)fluoranthene	&*** 0.091-3.1	0.062-1.4	X 10.0
Benzyl Alcohol	X 0.5-0.52	X 0.43-0.46	X 10.0
Bis(2-chloroethoxy)methane	X NA	X 0.43-0.46	X 10.0
Bis(2-chloroethyl) ether	X 0.5-0.52	X 0.39-0.49	X 10.0
Bis(2-chloroisopropyl) ether	X 0.5-0.52	X 0.43-0.46	X 10.0
Bis(2-ethylhexyl)phthalate	&* X 0.5-0.59	X 0.43	X 10.0
Butylbenzylphthalate	&* X 0.5-0.59	X 0.43-0.46	X 10.0
Chrysene	&*** 0.11-2.8	0.076-1.7	4.0-10.0
Dibenzofuran	&*** 0.5-0.65	0.17-0.46	1.0-10.0
Dibenzo(a,h)anthracene	&*** X 0.5-0.52	0.06-0.48	X 10
Diethylphthalate	X 0.5-0.52	X ND	X 10
Dimethylphthalate	X 0.5-0.52	X 0.43-0.46	X 10
Di-n-butylphthalate	&* X 0.5-0.52	X 0.43-0.46	X 10
Di-n-octylphthalate	&* X 0.5-0.52	X 0.43-0.46	X 10
Fluoranthene	&*** 0.073-8	0.088-3.7	6.0-10.0
Fluorene	&*** 0.5-1.2	0.2-0.73	1.0-21.0
Hexachlorobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
Hexachlorobutadiene	X 0.5-0.52	X 0.43-0.46	X 10.0
Hexachlorocyclopentadiene	X 0.5-0.52	X 0.43-0.46	X 10.0
Hexachloroethane	X 0.5-0.52	X 0.43-0.46	X 10.0
Indeno(123cd)pyrene	&*** X 0.5-0.52	0.071-0.62	X 10.0
Isochlorone	X 0.5-0.52	X 0.43-0.46	X 10.0
Naphthalene	&*** 0.48-0.52	0.078-0.43	X 10.0
Nitrobenzene	X 0.5-0.52	X 0.43-0.46	X 10.0
N-Nitroso-di-n-propylamine	X 0.5-0.52	X 0.43-0.46	X 10.0
N-Nitrosodiphenylamine	X 0.5-0.52	X 0.43-0.46	X 10.0
Pentachlorophenol	X 2.5-2.6	X 2.1-2.3	X 50.0
Phenanthrene	&*** 0.083-7.2	0.057-4.6	10.0-44.0
Phenol	&*** X 0.5-0.52	0.046-0.49	X ND
Pyrene	&*** 0.1-5.7	0.072-4.9	10.0-23.0
PESTICIDES			
4,4'-DDD	ND	ND	ND
4,4'-DDE	&*** 0.029-0.081	ND	ND
4,4'-DDT	&* 0.023-0.088	ND	ND
Aldrin	ND	ND	ND
Alpha-BHC	ND	ND	ND
Alpha-chlordane	ND	ND	ND
Beta-BHC	ND	ND	ND
Dieldrin	ND	ND	ND
Delta-BHC	ND	ND	ND
Endosulfan I	ND	ND	ND
Endosulfan II	ND	ND	ND
Endosulfan Sulfate	ND	ND	ND
Endrin	ND	ND	ND
Endrin ketone	ND	ND	ND
Gamma-BHC	ND	ND	ND
Gamma-chlordane	ND	ND	ND
Heptachlor	ND	ND	ND
Heptachlor epoxide	ND	ND	ND
Methoxychlor	ND	ND	ND
Toxaphene	ND	ND	ND
PCB's			
Aroclor-1016	ND	ND	ND
Aroclor-1221	ND	ND	ND
Aroclor-1232	ND	ND	ND
Aroclor-1242	ND	ND	ND
Aroclor-1248	ND	ND	ND
Aroclor-1254	08	ND	ND
Aroclor-1260	ND	ND	ND

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "UJ" qualified data only

ND Not Detected

TABLE 4-5
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE – OLD FIRE FIGHTING TRAINING CENTER

PARAMETER	VALUE OR RANGE	VALUE USED	RATIONALE
Global variables			
Body Weight (kg)			
Children			
~ scenario 1	11.6–17.4	14.6	Value based on average of males and females between 0–6 yrs
~ scenario 2	25–61.2	43.2	Value based on average of males and females between 6–18 yrs
Adult	67.2–74.6	70	Value based on adult body weight
Exposure Duration (years)			
~ scenario 1	1–18	6	Based upon the age range of children at day care
~ scenario 2	1–18	12	Based upon the age range of children (6–18 years)
~ scenario 3	1–70	1	Amount of time spent building an industrial facility
~ scenario 4	1–70	25	National upper-bound (90th percentile) at one job.
~ scenario 6			
Child	1–18	6	Number of years in this age group
Adult	1–70	30	National upper-bound (90th percentile) at one residence.
Averaging Time			
Cancer-risks (days)	NA	25,650	Value based upon 70 year life expectancy.
Noncancer-risks (days)			
~ scenario 1	350–25,650	1825	Value based upon exposure duration; 365 days/year
~ scenario 2	350–6570	4380	Value based upon exposure duration; 365 days/year
~ scenario 3	1–365	365	Value based upon exposure duration; 365 days/year
~ scenario 4	250–25,550	9125	Value based upon exposure duration; 365 days/year
~ scenario 5			
Child	350–2100	2190	Value based upon exposure duration; 365 days/year
Adult	350–25,550	10,950	Value based upon exposure duration; 365 days/year
Soil Contact Rate (mg/day)	500–1000	500	Soil deposition=0.5mg/m ³ ; skin surface area=2000cm ² ; fraction exposed=50%
Absorption Factor			
~ Dermal:			
VOC's	0–1	0.5	
PAHs/PCBs	0–1	0.05	
Inorganics	0–1	(0)	
Pesticides	0–1	0.05, 0.5	High/Low soil sorption, respectively
~ Ingestion:			
VOC's, PAHs	0–1	1	
Inorganics	0–1	1	
Pesticides	0–1	0.3; 1	High/Low soil sorption, respectively
Lead	0–1	0.5, 0.3	Children/Adults, respectively
~ Inhalation:			
Permeability Constant – Dermal contact in Water (cm/hr)	0–1	1	Complete absorption assumed
		8.4E–04	Based upon the penetration rate of water
Chemical Concentration Justification			Geometric mean and maximum values used in exposure estimates
Surface Soils, Subsurface soils; Ground Water			were calculated using the methods described in text

TABLE 4-5
(continued)
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE - OLD FIRE FIGHTING TRAINING CENTER

Scenario 1 - Child Care Current Use			
Exposure Frequency(days/year)	1-365	260	Five days per week, 50 weeks per year
Ingestion Of Chemicals In Soils			
Ingestion Rate (mg/day)	0-200	200	Soil ingestion rate for those over 6 years of age.
Scenario 2 - Recreational Exposure: Current Use			
Exposure Frequency(days/year)	1-365	33	
Ingestion Of Chemicals In Soils			
Ingestion Rate (mg/day)	0-200	100	Soil ingestion rate for those over 6 years of age.
Scenario 3 - Construction Exposure Future Use			
Exposure Frequency (days/year)	1-365	260	Based on estimate of days constructing industrial facility
Ingestion Of Chemicals In Soils			
Ingestion Rate (mg/day)	0-480	480	Soil ingestion rate for construction work.
Inhalation Of Airborne Chemicals Absorbed to Dust			
Inhalation Rate (m3/day)		14.4	Adults during moderate exertion (18 m3/hr; 8hr/day)
Scenario 4 - Industrial Exposure: Future Use			
Exposure Frequency (days/year)	1-365	250	Based on an estimate of the number of workdays in one year.
Ingestion Of Chemicals In Drinking Water			
Ingestion Rate (L/day)	0-2	1	Water ingestion rate for a commercial setting.
Ingestion Of Chemicals In Soils			
Ingestion Rate (mg/day)	0-480	50	Soil ingestion rate for a commercial setting.
Scenario 5 - Residential Scenario Future Use			
Exposure Frequency (days/yr)	1-365	350	Two weeks spent away from home
Ingestion Of Chemicals In Soils and House Dust			
Ingestion Rate (mg/day)			
Child	0-200	200	Children, 1-6 years old
Adult	0-100	100	Age groups greater than 6 years old
Ingestion Of Chemicals In Drinking Water			
Ingestion Rate (L/day)			
Child		0.750	Children, 0-6 years old
Adult		2	Adult, 90th percentile
Inhalation Of Airborne (Vapor Phase) Chemicals			
Inhalation Rate (m3/hr)		0.6	Adults and children, light activity assumed.
Exposure Time (hrs/day)	0.1-0.2	0.2 hr	Based upon the 90th % value for the duration of a shower.
Inhalation Of Airborne Chemicals Absorbed to Dust			
Inhalation Rate (m3/day)		20	Adults and children, light activity assumed.

TABLE 4-6
SCENARIO 1
SUMMARY OF CANCER RISK ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

CHEMICAL	CHRONIC DAILY INTAKE(CDI)-MEAN (mg/kg/day)	CHRONIC DAILY INTAKE(CDI)-MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL RISK MEAN	CHEMICAL RISK MAX	TOTAL PATHWAY RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL										1 4E-09	1 3E-04 MAXIMUM
										9 3E-10	2 8E-05 MEAN
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL										1 3E-04	MAXIMUM
										2 8E-05	MEAN
INORGANICS											
Arsenic	3 5E-08	6 0E-08	No	1 75E+00	A	Skin	IRIS	6 0E-08	1 1E-05		
SEMI-VOLATILES											
Benzo(a)anthracene	3 1E-07	2 2E-06	No	1 15E+01	B2	Liver, Lung, Skin	IRIS	3 5E-08	2 6E-05		
Benzo(a)pyrene	2 5E-07	1 8E-06	No	1 15E+01	B2	Lung, stomach	IRIS	2 9E-08	2 1E-05		
Benzo(b)fluoranthene	2 9E-07	1 9E-06	No	1 15E+01	B2	Lung, thorax, skin	IRIS	3 3E-08	2 2E-05		
Benzo(k)fluoranthene	2 4E-07	2 1E-06	No	1 15E+01	B2	Lung, thorax, skin	IRIS	2 8E-08	2 4E-05		
Chrysene	2 9E-07	1 9E-06	No	1 15E+01	B2	Malignant lymphoma	IRIS	3 4E-08	2 2E-05		

TABLE 4-7
 SCENARIO 1
 SUMMARY OF CHRONIC HAZARD INDEX RATIOS
 OLD FIRE FIGHTING TRAINING AREA

	PATHWAY HAZARD INDEX (HI)	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	8.1E-03 1.5E-01	4.3E-01 MAXIMUM 2.0E-01 MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	4.2E-01 1.9E-01	MAXIMUM MEAN

TABLE 4-8
SCENARIO 2
SUMMARY OF CANCER RISK ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.2E-10 8.1E-11	7.1E-06 MAXIMUM 1.5E-06 MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	7.1E-06 1.5E-06	MAXIMUM MEAN

TABLE 4-9
SCENARIO 2
SUMMARY OF CHRONIC HAZARD INDEX RATIOS
OLD FIRE FIGHTING TRAINING AREA

	PATHWAY HAZARD INDEX (HI)	PATHWAY HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	3.6E-04 6.7E-05	9.8E-03 MAXIMUM 4.4E-03 MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	9.4E-03 4.3E-03	MAXIMUM MEAN

TABLE 4-10
SCENARIO 3
SUMMARY OF CANCER RISK ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

	TOTAL PATHWAY RISK	TOTAL RISK
	2.1E-10	8.2E-06 MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	2.8E-10	2.0E-06 MEAN
	8.2E-06	MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.0E-06	MEAN
	1.3E-09	MAXIMUM
EXPOSURE PATHWAY: OUTDOOR INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST	6.3E-10	MEAN

TABLE 4-11
SCENARIO 3
SUMMARY OF SUBCHRONIC HAZARD INDEX RATIOS
OLD FIRE FIGHTING TRAINING AREA

	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.2E-04 3.5E-05	2.7E-01 MAXIMUM 8.8E-02 MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.7E-01 8.7E-02	MAXIMUM MEAN
EXPOSURE PATHWAY: OUTDOOR INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST	6.9E-04 2.1E-04	MAXIMUM MEAN

TABLE 4-12
SCENARIO 4
SUMMARY OF CANCER RISK ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

CHEMICAL	CHRONIC DAILY INTAKE (CDI) - MEAN (mg/kg/day)	CHRONIC DAILY INTAKE (CDI) - MAX. (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day) - 1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL RISK MEAN	CHEMICAL RISK MAXIMUM	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL										1.4E-09	3.1E-03 MAXIMUM
										1.2E-09	1.5E-03 MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL										3.5E-05	MAXIMUM
										8.5E-06	MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER										3.0E-03	MAXIMUM
										1.5E-03	MEAN
INORGANICS											
Arsenic	1.5E-05	5.8E-05	No	1.75E+00	A	Skin	IRIS	2.8E-05	1.0E-04		
SEMIVOLATILES											
Benzo(a)anthracene	1.8E-05	3.5E-05	No	1.15E+01	B2	Liver, Lung, Skin	IRIS	2.1E-04	4.0E-04		
Benzo(a)pyrene	1.7E-05	3.5E-05	No	1.15E+01	B2	Lung, stomach	IRIS	1.9E-04	4.0E-04		
Benzo(b)fluoranthene	1.5E-05	3.5E-05	No	1.15E+01	B2	Lung, thorax, skin	IRIS	1.7E-04	4.0E-04		
Benzo(k)fluoranthene	2.0E-05	3.5E-05	No	1.15E+01	B2	Lung, thorax, skin	IRIS	2.3E-04	4.0E-04		
Chrysene	1.9E-05	3.5E-05	No	1.15E+01	B2	Malignant lymphoma	IRIS	2.2E-04	4.0E-04		
Dibenzo(a,h)anthracene	2.0E-05	3.5E-05	No	1.15E+01	B2	Lung, Mammary	IRIS	2.3E-04	4.0E-04		
Indeno(123cd)pyrene	2.0E-05	3.5E-05	No	1.15E+01	B2	Lung, skin	IRIS	2.3E-04	4.0E-04		

TABLE 4-13
SCENARIO 4
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

CHEMICAL	CHRONIC DAILY INTAKE (CDI) - MEAN (mg/kg/day)	CHRONIC DAILY INTAKE (CDI) - MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENT	MODIFYING FACTORS	HAZARD QUOTIENT MEAN	HAZARD QUOTIENT MAXIMUM	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL												1.7E-03	3.1E+00 MAXIMUM
												4.2E-04	8.2E-01 MEAN
												2.2E-02	MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL												1.0E-02	MEAN
												3.1E+00	MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER												8.1E-01	MEAN
INORGANICS													
Cadmium	2.9E-05	4.8E-04	No	1E-03	High	Proteinuria	Diet/IRIS, HEAST	10	1	2.9E-02	4.8E-01		
Manganese	4.4E-02	8.5E-02	No	1E-01	Medium	CNS effects	Diet/IRIS, HEAST	1	1	4.4E-01	8.5E-01		
Zinc	4.4E-03	1.2E-01	No	2E-01		Anemia	Therapeutic/HEAST	10		2.2E-02	8.1E-01		

TABLE 4-14
SCENARIO 5
SUMMARY OF CANCER RISK ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

CHEMICAL	CDI-CHILD MEAN (mg/kg/day)	CDI-ADULT MEAN (mg/kg/day)	CDI-CHILD MAX (mg/kg/day)	CDI-ADULT MAX (mg/kg/day)	CDI ADJ FOR ABSORPTION	SF (mg/kg/day) ⁻¹	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL RISK CHILD MEAN	CHEMICAL RISK ADULT MEAN	CHEMICAL RISK CHILD MAXIMUM	CHEMICAL RISK ADULT MAXIMUM	TOTAL PATHWAY RISK	TOTAL PATHWAY RISK
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER															1.9E-03 CHILD MEAN 5.1E-03 ADULT MEAN 3.7E-03 CHILD MAXIMUM 1.0E-02 ADULT MAXIMUM
INORGANICS															
Arsenic	1.9E-05	5.0E-05	7.1E-05	1.9E-04	No	1.75E+00	A	Skin	IRIS	3.1E-05	8.7E-05	1.2E-04	3.4E-04		
Beryllium	2.9E-05	8.0E-05	1.0E-05	2.8E-05	No	4.30E+00	B2	Gross tumors, all sites combined	Water/IRIS	1.3E-05	3.6E-05	4.4E-05	1.2E-04		
VOLATILES															
1,1-Dichloroethene	1.9E-05	5.3E-05	1.1E-04	2.9E-04	No	6.0E-01	C	Adrenal pheochromocytomas	Oral/IRIS	1.2E-05	3.2E-05	6.4E-05	1.8E-04		
SEMIVOLATILES															
Benzo(a)anthracene	2.2E-05	8.1E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Liver, Lung, Skin	IRIS	2.6E-04	7.0E-04	4.9E-04	1.4E-03		
Benzo(a)pyrene	2.0E-05	5.6E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, stomach	IRIS	2.3E-04	6.6E-04	4.9E-04	1.4E-03		
Benzo(b)fluoranthene	1.6E-05	4.9E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, thorax, skin	IRIS	2.0E-04	5.6E-04	4.9E-04	1.4E-03		
Benzo(k)fluoranthene	2.4E-05	6.7E-05	ERR	ERR	No	1.15E+01	B2	Lung, thorax, skin	IRIS	2.6E-04	7.8E-04	4.9E-04	1.4E-03		
Chrysene	2.3E-05	6.4E-05	ERR	ERR	No	1.15E+01	B2	Malignant lymphoma	IRIS	2.7E-04	7.4E-04	4.9E-04	1.4E-03		
Indeno(1,2,3-cd)pyrene	2.4E-05	6.7E-05	ERR	ERR	No	1.15E+01	B2	Lung, skin	IRIS	2.6E-04	7.8E-04	4.9E-04	1.4E-03		
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL															1.6E-09 CHILD MEAN 1.6E-09 ADULT MEAN 2.4E-09 CHILD MAXIMUM 2.4E-09 ADULT MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST															4.6E-05 CHILD MEAN 2.5E-05 ADULT MEAN 2.3E-04 CHILD MAXIMUM 1.2E-04 ADULT MAXIMUM
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS															8.4E-06 CHILD MEAN 8.7E-06 ADULT MEAN 4.6E-06 CHILD MAXIMUM 4.6E-06 ADULT MAXIMUM
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST															3.2E-06 CHILD MEAN 3.3E-06 ADULT MEAN 5.2E-06 CHILD MAXIMUM 5.4E-06 ADULT MAXIMUM

TABLE 4-15
SCENARIO 5
SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES
OLD FIRE FIGHTING TRAINING AREA

CHEMICAL	CDI- CHILD MEAN (mg/kg/day)	CDI- ADULT MEAN (mg/kg/day)	CDI- CHILD MAX (mg/kg/day)	CDI- ADULT MAX (mg/kg/day)	CDI ADJ FOR ABS	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENT	MF	HI CHILD MEAN	HI ADULT MEAN	HI CHILD MAX	HI ADULT MAX	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)									
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER																		4.1E+00	4.4E+00	CHILD MEAN						
																		2.3E+00	2.3E+00	ADULT MEAN						
																		1.8E+01	1.8E+01	CHILD MAXIMUM						
																		8.8E+00	8.8E+00	ADULT MAXIMUM						
INORGANICS																										
Cadmium	1.5E-04	8.2E-05	2.4E-03	1.3E-03	No	1E-03	High	Proteinuria	Dialysis, HEAST	10	1	1.5E-01	8.2E-02	2.4E+00	1.3E+00			2.1E-03	CHILD MEAN							
Copper	3.1E-03	1.7E-03	5.1E-02	2.8E-02	No	4E-02		Local GI irritation	HEAST			7.8E-02	4.3E-02	1.3E+00	7.1E-01			4.4E-04	ADULT MEAN							
Manganese	2.2E-01	1.2E-01	4.3E-01	2.4E-01	No	1E-01	Medium	CNS effects	Dialysis, HEAST	1	1	2.2E+00	1.2E+00	4.3E+00	2.4E+00			1.1E-02	CHILD MAXIMUM							
Zinc	2.2E-02	1.2E-02	8.2E-01	3.4E-01	No	2E-01		Anemia	Therapeutic/HEAST	10		1.1E-01	8.1E-02	3.1E+00	1.7E+00			2.3E-03	ADULT MAXIMUM							
																		2.1E-03		CHILD MEAN						
																		4.4E-04		ADULT MEAN						
																		1.1E-02		CHILD MAXIMUM						
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL																		2.3E-03		ADULT MAXIMUM						
																		2.7E-01		CHILD MEAN						
																		2.8E-02		ADULT MEAN						
																		5.9E-01		CHILD MAXIMUM						
																		8.1E-02		ADULT MAXIMUM						
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																										
																		3.8E-02		CHILD MEAN						
																		7.9E-03		ADULT MEAN						
																		2.1E-01		CHILD MAXIMUM						
																		4.3E-02		ADULT MAXIMUM						
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																										
																		1.2E-03		CHILD MEAN						
																		2.5E-04		ADULT MEAN						
																		3.5E-03		CHILD MAXIMUM						
																		7.2E-04		ADULT MAXIMUM						
EXPOSURE PATHWAY OUTDOOR INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																										

TABLE 4-16
SUMMARY OF EXPOSURE PATHWAYS
OLD FIRE FIGHTING TRAINING CENTER

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Inclusion
Current Land Use			
Children	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Children	Ingestion of soils on site	Yes	Access to site unrestricted
Children	Ingestion of sediments on site	No	Soils data includes contamination near shore
Children	Ingestion of surface water on site	No	Data not available
Children	Dermal contact with soils	Yes	Access to site unrestricted
Children	Dermal contact with sediments	No	Soils data includes contamination near shore
Children	Inhalation of fugitive dusts	No	Site vegetated
Children	Dermal contact with surface water	No	Data not available
Future Land Use			
Residents	Ingestion of ground water from local wells on the site	Yes	Potential residential use of site
Residents	Ingestion of soils on site	Yes	Potential residential use of site
Residents	Ingestion of sediments on site	No	Soils data includes contamination near shore
Residents	Ingestion of surface water on site	No	Contact route unlikely; ground water available for ingestion
Residents	Dermal contact with soils	Yes	Potential residential use of site
Residents	Dermal contact with sediments	No	Soils data includes contamination near shore
Residents	Inhalation of fugitive dusts	Yes	Potential residential use of site may produce areas devoid of cover
Residents	Inhalation of chemicals volatilized from ground water during home use	Yes	Potential residential use of site; volatile organics in ground water
Construction Workers	Ingestion of ground water from local wells	No	Wells not developed during construction
Construction Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Construction Workers	Ingestion of sediments on site	No	Soils data includes contamination near shore
Construction Workers	Ingestion of surface water on site	No	Contact route unlikely
Construction Workers	Dermal contact with soils	Yes	Contact with soils expected during construction
Construction Workers	Dermal contact with sediments	No	Contact route unlikely
Construction Workers	Inhalation of fugitive dusts	Yes	Generation of fugitive dust expected during construction
Industrial Workers	Ingestion of ground water from local wells	Yes	Potential future use of ground water as potable supply
Industrial Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Industrial Workers	Ingestion of sediments on site	No	Soils data includes contamination near shore
Industrial Workers	Ingestion of surface water on site	No	Contact route unlikely
Industrial Workers	Dermal contact with soils	Yes	Contact with soils expected
Industrial Workers	Dermal contact with sediments	No	Contact route unlikely
Industrial Workers	Inhalation of fugitive dusts	No	Generation of fugitive dust not expected

TABLE 6-1
SUMMARY OF SURFACE SOIL DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U S BACKGROUND (mg/kg)b	RANGE OF U S BACKGROUND (mg/kg)b
INORGANICS							
Aluminum	5/5	(0.2)a	2110-12200	5816.05	12200	33000	7000-100000
Antimony	4/5	(0.06)a	3.5-4.7	4.20	4.7	0.52	<1-8
Arsenic	2/5	2.5-3.2	0.0-9.5	4.50	8.5	4.8	0.1-73
Barium	3/5	7.1-10.6	15.5-32.8	15.01	32.8	290	10-1500
Beryllium	3/5	0.2-0.22	0.2-0.52	0.25	0.52	0.55	1-7
Cadmium	0/5	0.54-0.65	NA	NA	NA	0.26 c	NA
Calcium	5/5	(5.0)a	633-1030	788.36	1030	3400	100-290000
Chromium	4/5	1.0	3.7-15.1	6.79	15.1	33	1-1000
Cobalt	3/5	3.4-6.3	12.5-19.3	9.36	19.3	5.9	0.3-70
Copper	3/5	7.3-8.8	13.6-25.8	13.71	25.8	13	1-700
Cyanide	0/3	0.53-0.88	NA	NA	NA	NA	NA
Iron	5/5	(0.1)a	10800-41100	20823.72	41100	14000	100-100000
Lead	5/5	(0.005)a	11.5-40	18.43	40	14	10-300
Magnesium	5/5	(5.0)a	861-2610	1804.31	2610	2100	50-50000
Manganese	5/5	(0.015)a	106-471	300.65	471	260	2-7000
Mercury	1/5	0.11-0.24	0.13	0.17	0.24	0.061	0.01-3.4
Nickel	3/5	6.6-7.3	18.5-27.2	13.53	27.2	11	5-700
Potassium	4/5	838	182-253	253.56	253	12000	50-37000
Selenium	0/5	0.34-0.44	NA	NA	NA	0.3	0.1-3.9
Silver	0/5	0.59-1.7	NA	NA	NA	NA	NA
Sodium	0/5	17.9-282	NA	NA	NA	2500	500-50000
Thallium	4/5	(0.01)a	0.68-0.88	0.73	0.88	7.7	2.2-23
Tin	2/5	2.5-10.5	17.9-19.1	9.78	19.1	43	7-300
Zinc	4/5	33	55.9-83.4	59.52	83.4	40	5-2900
VOLATILES							
1,1-Dichloroethane	0/5	0.006-0.31	NA	NA	NA	NA	NA
1,1-Dichloroethene	0/5	0.006-0.31	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
1,1,2-Trichloroethane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
1,1,2,2-Tetrachloroethane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
1,2-Dichloroethane	0/5	0.006-0.31	NA	NA	NA	NA	NA
1,2-Dichloroethene	0/5	0.006-0.31	NA	NA	NA	NA	NA
1,2-Dichloropropane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
1,3-Dichloropropane (Cis)	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
1,3-Dichloropropane (Trans)	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
2-Butanone	0/5	0.013-0.05	NA	NA	NA	NA	NA
2-Hexanone	2/5	0.012-0.05	0.013-1.2	0.041	1.2	NA	NA
4-Methyl-2-Pentanone	2/5	0.012-0.05	0.013-1.2	0.041	1.2	NA	NA
Acetone	0/5	0.01-0.6	NA	NA	NA	NA	NA
Benzene	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Bromodichloromethane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Bromoforn	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Bromomethane	0/5	0.012-1.2	NA	NA	NA	NA	NA
Carbon disulfide	2/5	0.006-0.31	0.006-0.025	0.018	0.025	NA	NA
Carbon Tetrachloride	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Chlorobenzene	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Chloroethane	0/5	0.012-1.2	NA	NA	NA	NA	NA
Chloroform	0/5	0.006-0.31	NA	NA	NA	NA	NA
Chloromethane	0/5	0.012-1.2	NA	NA	NA	NA	NA
Dibromochloromethane	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Ethylbenzene	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Methylene chloride	0/5	0.009-0.92	NA	NA	NA	NA	NA
Styrene	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Tetrachloroethane	2/5	0.006-0.025	0.002-0.68	0.017	0.002	NA	NA
Toluene	2/5	0.006-0.31	0.006	0.013	0.006	NA	NA
Trichloroethene	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA
Vinyl acetate	2/5	0.013-0.05	0.012-0.6	0.036	0.05	NA	NA
Vinyl Chloride	0/5	0.012-1.2	NA	NA	NA	NA	NA
Xylenes	1/5	0.006-0.31	0.006	0.018	0.006	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
b. U.S. background range and average concentration are from (USGS, 1984)
c. Average U.S. background (Carey, 1979)
NA. Not Applicable

TABLE 5-1 (cont.)
SUMMARY OF SURFACE SOIL DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
SEMIVOLATILES							
1,2-Dichlorobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
1,2,4-Trichlorobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
1,3-Dichlorobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
1,4-Dichlorobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2-Chloronaphthalene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2-Chlorophenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2-Methylnaphthalene	1/5	0.42-20.0	0.10	0.80	0.19	NA	NA
2-Methylphenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2-Nitroaniline	1/5	2.1-100	2.5	4.80	2.50	NA	NA
2-Nitrophenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2,4-Dichlorophenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2,4-Dimethylphenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2,4-Dinitrophenol	1/5	2.1-10.0	2.5	4.80	2.50	NA	NA
2,4-Dinitrotoluene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2,4,5-Trichlorophenol	1/5	2.1-100	2.5	4.80	2.50	NA	NA
2,4,6-Trichlorophenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
2,6-Dinitrotoluene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
3-Nitroaniline	1/5	0.42-20.0	0.5	4.80	2.50	NA	NA
3,3'-Dichlorobenzidine	1/5	0.84-40.0	1.0	1.93	1.00	NA	NA
4-Bromophenyl-phenylether	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
4-Chloro-3-methylphenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
4-Chloroaniline	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
4-Chlorophenyl-phenylether	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
4-Methylphenol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
4-Nitroaniline	1/5	2.1-10.0	2.5	4.80	2.50	NA	NA
4-Nitrophenol	1/5	2.1-10.0	2.5	4.80	2.50	NA	NA
4,6-dinitro-2-methylphenol	1/5	2.1-10.0	2.5	4.80	2.50	NA	NA
Acenaphthene	1/5	0.42-20.0	0.070	0.68	0.08	NA	NA
Acenaphthylene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Anthracene	1/5	0.42-20.0	0.13	0.74	0.13	NA	NA
Benzic acid	1/5	2.1-100	2.5	4.80	2.50	NA	NA
Benzofluoranthene	3/5	0.43-20.0	0.1-0.18	0.44	0.16	NA	NA
Benzo(a)pyrene	3/5	0.43-20.0	0.075	0.38	0.11	NA	NA
Benzo(b)fluoranthene	1/5	0.42-20.0	0.088	0.89	0.08	NA	NA
Benzo(g,h,i)perylene	0/5	0.42-20.0	NA	NA	NA	NA	NA
Benzo(k)fluoranthene	0/5	0.42-20.0	NA	NA	NA	NA	NA
Benzyl Alcohol	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Bis(2-chloroethoxy)methane	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Bis(2-chloroethoxy)ether	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Bis(2-chloroisopropoxy)ether	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Bis(2-ethylhexyloxy)phthalate	1/5	0.43-0.87	8.8	0.99	8.80	NA	NA
Butylbenzylphthalate	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Chrysene	4/5	0.43	0.12-8.8	0.44	9.80	NA	NA
Dibenzofuran	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Dibenzo(a,h)anthracene	0/5	0.42-20.0	NA	NA	NA	NA	NA
Dibenzophthalate	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Dimethylphthalate	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Di-n-butylphthalate	1/5	0.42-20.0	0.05	0.51	0.06	NA	NA
Di-n-octylphthalate	0/5	0.42-20.0	NA	NA	NA	NA	NA
Fluoranthene	3/5	0.43-20.0	0.13-0.26	0.59	0.26	NA	NA
Fluorene	1/5	0.42-20.0	0.19	0.80	0.19	NA	NA
Hexachlorobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Hexachlorobutadiene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Hexachlorocyclopentadiene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Hexachloroethane	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Indeno(1,2,3-cd)pyrene	0/5	0.42-20.0	NA	NA	NA	NA	NA
Isophorone	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Naphthalene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Nitrobenzene	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
N-nitroso-di-n-propylamine	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
N-nitrosodiphenylamine	1/5	0.42-20.0	0.5	0.97	0.50	NA	NA
Pentachlorophenol	1/5	2.1-10.0	2.5	4.80	2.50	NA	NA
Phenanthrene	4/5	0.43	0.12-7.3	0.50	7.30	NA	NA
Phenol	2/5	0.42-20.0	0.052-0.15	0.50	0.15	NA	NA
Pyrene	2/5	0.42-0.47	0.48-8.0	0.75	8.00	NA	NA
PESTICIDES							
2,4-D	2/2	NA	0.0021-0.0024	0.0022	0.0024	NA	NA
2,4,6-T	2/2	NA	0.0011-0.0012	0.0011	0.0012	NA	NA
2,4,6-TP (Silvex)	2/2	NA	0.0011-0.0012	0.0011	0.0012	NA	NA
4,4'-DDD	0/2	0.036-0.041	NA	NA	NA	NA	NA
4,4'-DDE	1/2	0.041	0.0045	0.0045	0.0045	NA	NA
4,4'-DDT	0/2	0.036-0.041	NA	NA	NA	NA	NA
Aldrin	0/2	0.018-0.021	NA	NA	NA	NA	NA
Alpha-BHC	0/2	0.018-0.021	NA	NA	NA	NA	NA
Alpha-chlorodane	0/2	0.18-0.21	NA	NA	NA	NA	NA
Beta-BHC	0/2	0.018-0.021	NA	NA	NA	NA	NA
Deltrin	0/2	0.036-0.041	NA	NA	NA	NA	NA
Delta-BHC	0/2	0.018-0.021	NA	NA	NA	NA	NA
Endosulfan I	0/2	0.018-0.021	NA	NA	NA	NA	NA
Endosulfan II	0/2	0.036-0.041	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/2	0.036-0.041	NA	NA	NA	NA	NA
Endrin	1/3	0.036-0.041	0.00021	0.0002	0.00021	NA	NA
Endrin ketone	0/2	0.036-0.041	NA	NA	NA	NA	NA
Gamma-BHC	1/3	0.018-0.021	0.00011	0.0001	0.00011	NA	NA
Gamma-chlorodane	0/2	0.18-0.21	NA	NA	NA	NA	NA
Heptachlor	0/2	0.018-0.021	NA	NA	NA	NA	NA
Heptachlor epoxide	0/2	0.018-0.021	NA	NA	NA	NA	NA
Methoxychlor	1/3	0.18-0.21	0.0011	0.0011	0.0011	NA	NA
Toxaphene	1/3	0.36-0.41	0.0021	0.0021	0.0021	NA	NA
PCB's							
Aroclor-1018	0/3	0.18-0.21	NA	NA	NA	NA	NA
Aroclor-1221	0/3	0.18-0.21	NA	NA	NA	NA	NA
Aroclor-1232	0/3	0.18-0.21	NA	NA	NA	NA	NA
Aroclor-1242	0/3	0.18-0.21	NA	NA	NA	NA	NA
Aroclor-1248	0/3	0.18-0.21	NA	NA	NA	NA	NA
Aroclor-1254	0/3	0.36-0.41	NA	NA	NA	NA	NA
Aroclor-1260	0/3	0.36-0.41	NA	NA	NA	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQR).

b. U.S. background range and average concentration are from (USGS, 1984).

c. Average U.S. background (Carey, 1970).

NA: Not Applicable

TABLE 5-2
SUMMARY OF SUBSURFACE SOIL DATA
FROM TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
INORGANICS							
Aluminum	5/5	(0.2) ^a	1010-11700	3975	11700	33000	7000-100000
Antimony	5/5	(0.06) ^a	5.6-8.7	6.70	8.7	0.52	<1-8.8
Arsenic	5/5	(0.01) ^a	3.2-18.7	11.38	18.7	4.8	0.1-73
Barium	5/5	(0.2) ^a	5.6-21.9	9.01	21.9	290	10-1500
Beryllium	5/5	(0.005) ^a	0.27-0.47	0.34	0.47	0.55	1-7
Cadmium	0/5	0.54-0.68	NA	NA	NA	0.28 ^c	NA
Calcium	5/5	(5.0) ^a	143-1520	443	1520	3400	100-280000
Chromium	5/5	(0.01) ^a	3.8-19.1	8.83	19.1	33	1-1000
Cobalt	5/5	(0.05) ^a	11.7-22	17.50	22	5.9	0.3-70
Copper	5/5	(0.025) ^a	13.8-35.2	20.03	35.2	13	1-700
Cyanide	0/5	0.52-0.81	NA	NA	NA	NA	NA
Iron	5/5	(0.1) ^a	18400-41000	32300	41000	14000	100-100000
Lead	5/5	(0.005) ^a	4.1-11.9	6.59	11.9	14	10-300
Magnesium	0/5	(5.0) ^a	400-4480	1535	4480	2100	50-50000
Manganese	5/5	(0.015) ^a	308-642.5	492	642.5	260	2-7000
Mercury	0/5	0.10-0.12	NA	NA	NA	0.081	0.01-3.4
Nickel	5/5	(0.04) ^a	14.6-37.7	27.10	37.7	11	5-700
Potassium	1/5	128-150	428	89	428	12000	50-37000
Selenium	5/5	(0.005) ^a	0.31-0.41	0.35	0.41	0.3	0.1-3.9
Silver	1/5	0.54-0.68	0.825	0.34	0.625	NA	NA
Sodium	0/5	15.8-20.1	NA	NA	NA	2500	500-50000
Thallium	4/5	0.83	0.81-0.89	0.80	0.89	7.7	2.2-23
Vanadium	5/5	(0.05) ^a	11.1-20.7	14.55	20.7	43	7-300
Zinc	5/5	(0.02) ^a	48.3-103	76.46	103	40	5-2900
VOLATILES							
1,1-Dichloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,1-Dichloroethene	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,2-Dichloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,2-Dichloroethene	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,2-Dichloropropane	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,3-Dichloropropene (Cis)	0/5	0.005-0.006	NA	NA	NA	NA	NA
1,3-Dichloropropene (Trans)	0/5	0.005-0.006	NA	NA	NA	NA	NA
2-Butanone	0/5	(0.01) ^a	NA	NA	NA	NA	NA
2-Hexanone	0/5	0.011-0.01	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	0/5	0.011-0.01	NA	NA	NA	NA	NA
Acetone	0/5	0.006-0.025	NA	NA	NA	NA	NA
Benzene	0/5	0.005-0.006	NA	NA	NA	NA	NA
Bromodichloromethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
Bromoform	0/5	0.005-0.006	NA	NA	NA	NA	NA
Bromomethane	0/5	0.011-0.01	NA	NA	NA	NA	NA
Carbon disulfide	0/5	0.005-0.006	NA	NA	NA	NA	NA
Carbon Tetrachloride	0/5	0.005-0.006	NA	NA	NA	NA	NA
Chlorobenzene	0/5	0.005-0.006	NA	NA	NA	NA	NA
Chloroethane	0/5	0.011-0.01	NA	NA	NA	NA	NA
Chloroform	0/5	0.005-0.006	NA	NA	NA	NA	NA
Chloromethane	0/5	0.011-0.01	NA	NA	NA	NA	NA
Dibromochloromethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
Ethylbenzene	0/5	0.005-0.006	NA	NA	NA	NA	NA
Methylene chloride	0/5	0.01-0.015	NA	NA	NA	NA	NA
Styrene	0/5	0.005-0.006	NA	NA	NA	NA	NA
Tetrachloroethane	1/5	0.005-0.006	0.002	0.0027	0.0020	NA	NA
Toluene	3/5	0.005-0.006	0.001-0.002	0.0020	0.0020	NA	NA
Trichloroethane	0/5	0.005-0.006	NA	NA	NA	NA	NA
Vinyl acetate	0/5	0.011-0.01	NA	NA	NA	NA	NA
Vinyl chloride	0/5	0.011-0.01	NA	NA	NA	NA	NA
Xylenes	0/5	0.005-0.006	NA	NA	NA	NA	NA

a SQLs in parenthesis are the contract required quantitation limits (CRL)
b U.S. background range and average concentration are from (USGS 1984)
c Average U.S. background (Carey, 1979)
NA Not Applicable

TABLE 5-2 (cont.)
SUMMARY OF SUBSURFACE SOIL DATA
FROM TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SOIL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
SEMIVOLATILES							
1,2-Dichlorobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
1,2,4-Trichlorobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
1,3-Dichlorobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
1,4-Dichlorobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2-Chloronaphthalene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2-Chlorophenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2-Methylnaphthalene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2-Methylphenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2-Nitroaniline	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
2-Nitrophenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2,4-Dichlorophenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2,4-Dimethylphenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2,4-Dinitrophenol	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
2,4-Dinitrotoluene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2,4,5-Trichlorophenol	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
2,4,6-Trichlorophenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
2,6-Dinitrotoluene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
3-Nitroaniline	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
3,3'-Dichlorobenzidine	1/5	0.77-0.83	0.77	0.46	0.77	NA	NA
4-Bromophenyl-phenylether	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
4-Chloro-3-methylphenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
4-Chloroaniline	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
4-Chlorophenyl-phenylether	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
4-Methylphenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
4-Nitroaniline	2/5	1.9-2.1	1.9-2.0	1.31	2.00	NA	NA
4-Nitrophenol	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
4,6-dinitro-2-methylphenol	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
Acenaphthene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Acenaphthylene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Anthracene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzoic acid	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
Benzo(a)anthracene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzo(a)pyrene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzo(b)fluoranthene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzo(ghi)perylene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzo(k)fluoranthene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Benzyl Alcohol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Bis(2-chloroethoxy)methane	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Bis(2-chloroethyl)ether	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Bis(2-chloroisopropyl)ether	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Bis(2-ethylhexyl)phthalate	0/5	0.38-0.42	NA	NA	NA	NA	NA
Butylbenzylphthalate	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Chrysene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Dibenzofuran	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Dibenzo(a,h)anthracene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Diethylphthalate	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Dimethylphthalate	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Di-n-butylphthalate	1/5	0.38-0.42	0.38	0.35	3.30	NA	NA
Di-n-octylphthalate	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Fluoranthene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Fluorene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Hexachlorobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Hexachlorobutadiene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Hexachlorocyclopentadiene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Hexachloroethane	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Indeno(1,2,3-cd)pyrene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Isophorone	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Naphthalene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Nitrobenzene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
N-nitroso-di-n-propylamine	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
N-nitrosodiphenylamine	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Pentachlorophenol	1/5	1.9-2.1	1.9	1.14	1.90	NA	NA
Phenanthrene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Phenol	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
Pyrene	1/5	0.38-0.42	0.38	0.23	0.38	NA	NA
PESTICIDES							
4,4'-DDD	0/5	0.018	NA	NA	NA	NA	NA
4,4'-DDE	0/5	0.018	NA	NA	NA	NA	NA
4,4'-DDT	1/5	0.018	0.017	0.009	0.017	NA	NA
Alldn	1/5	0.0088-0.009	0.003	0.004	0.003	NA	NA
Alpha-BHC	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Alpha-chlordane	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Beta-BHC	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Deslin	1/5	0.018	0.01	0.009	0.010	NA	NA
Delta-BHC	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Endosulfan I	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Endosulfan II	0/5	0.018	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/5	0.018	NA	NA	NA	NA	NA
Endnn	1/5	0.018	0.0082	0.009	0.008	NA	NA
Endnn ketone	0/5	0.018	NA	NA	NA	NA	NA
Gamma-BHC	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Gamma-chlordane	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Heptachlor	1/5	0.0088-0.009	0.003	0.004	0.003	NA	NA
Heptachlor epoxide	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Methoxychlor	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Toxaphene	0/5	0.18	NA	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Aroclor-1221	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Aroclor-1232	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Aroclor-1242	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Aroclor-1248	0/5	0.0088-0.009	NA	NA	NA	NA	NA
Aroclor-1254	0/5	0.034-0.18	NA	NA	NA	NA	NA
Aroclor-1260	0/5	0.18	NA	NA	NA	NA	NA

a. SOLs in parenthesis are the contract required quantitation limits (CQL)
b. U.S. background range and average concentration are from (USGS, 1984)
c. Average U.S. background (Carey, 1979)
NA Not Applicable

TABLE 5-3
SUMMARY OF GROUND WATER DATA
FROM TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN CONCENTRATION (µg/L)	MAXIMUM CONCENTRATION (µg/L)	ON SITE BACKGROUND LEVEL MW-5D (µg/L)
INORGANICS						
Aluminum	10/10	(200)a	84-251000	5037.4	251000	513
Antimony	0/10	22	NA	NA	NA	<22
Arsenic	10/10	(10)a	2-448	13.9	448	2.1
Barium	10/10	(200)a	5-878	50.5	878	10.9
Beryllium	3/10	1	7.2-8.5	1.1	8.5	<1
Cadmium	10/10	(5)a	3-8.5	3.8	8.5	3
Calcium	10/10	(5000)a	8050-98800	28129	98800	14000
Chromium	7/10	2	4-381	18.8	381	8
Cobalt	10/10	(50)a	8.8-659	49.0	659	9.7
Copper	10/10	(25)a	5.1-569	33.8	569	18.4
Cyanide	0/10	10	NA	NA	NA	5
Iron	10/10	(100)a	3450-98200	25734	98200	19000
Lead	10/10	(5)a	3-158	17.2	158	8
Magnesium	10/10	(5000)a	9220-98200	34597	98200	23400
Manganese	10/10	(15)a	585-11500	2291.7	11500	1240
Mercury	0/10	0.2	NA	NA	NA	<0.2
Nickel	4/10	17.7-66.9	81.5-749	57.8	749	<33.7
Potassium	10/10	(5000)a	723-12800	2389	12800	723
Selenium	10/10	(5)a	2.0-20.0	3.2	20	2
Silver	10/10	(10)a	3-30.8	5.8	30.8	3
Sodium	10/10	(5000)a	2280-27700	13187	27700	28100
Thallium	10/10	(10)a	4-40	10.0	40	4
Vandium	2/10	5.8-35.6	114-188	13.2	188	<7.9
Zinc	8/10	18.0-42.7	60.8-1450	145.0	1450	66.4
VOLATILES						
1,1-Dichloroethane	0/11	5	NA	NA	NA	<5
1,1-Dichloroethene	0/11	5	NA	NA	NA	<5
1,1,1-Trichloroethane	0/11	5	NA	NA	NA	<5
1,1,2-Trichloroethane	0/11	5	NA	NA	NA	<5
1,1,2,2-Tetrachloroethane	0/11	5	NA	NA	NA	<5
1,2-Dichloroethane	0/11	5	NA	NA	NA	<5
1,2-Dichloroethene	0/11	5	NA	NA	NA	<5
1,2-Dichloropropene	0/11	5	NA	NA	NA	<5
1,3-Dichloropropene (Cis)	0/11	5	NA	NA	NA	<5
1,3-Dichloropropene (Trans)	0/11	5	NA	NA	NA	<5
2-Butanone	0/11	10	NA	NA	NA	<10
2-Hexanone	0/11	10	NA	NA	NA	<10
4-Methyl-2-Pentanone	0/11	10	NA	NA	NA	<10
Acetone	0/11	2-10	NA	NA	NA	<10
Benzene	0/11	5	NA	NA	NA	<5
Bromodichloromethane	0/11	5	NA	NA	NA	<5
Bromoforn	0/11	5	NA	NA	NA	<5
Bromomethane	0/11	10	NA	NA	NA	<10
Carbon disulfide	0/11	5	NA	NA	NA	<5
Carbon Tetrachloride	0/11	5	NA	NA	NA	<5
Chlorobenzene	0/11	5	NA	NA	NA	<5
Chloroethane	0/11	10	NA	NA	NA	<10
Chloroform	0/11	5	NA	NA	NA	<5
Chloromethane	0/11	10	NA	NA	NA	<10
Dibromochloromethane	0/11	5	NA	NA	NA	<5
Ethylbenzene	0/11	5	NA	NA	NA	<5
Methylene chloride	0/11	5-8	NA	NA	NA	<8
Styrene	0/11	5	NA	NA	NA	<5
Tetrachloroethane	0/11	5	NA	NA	NA	<5
Toluene	0/11	5	NA	NA	NA	<5
Trichloroethene	0/11	5	NA	NA	NA	<5
Vinyl acetate	0/11	10	NA	NA	NA	<10
Vinyl chloride	0/11	10	NA	NA	NA	<10
Xylenes	0/11	5	NA	NA	NA	<5

a. SQLs in parenthesis are the contract required quantitation limits (CQL)
NA Not Applicable

TABLE 5-3 (cont)
SUMMARY OF GROUND WATER DATA
FROM TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN CONCENTRATION (µg/L)	MAXIMUM CONCENTRATION (µg/L)	ON SITE BACKGROUND LEVEL MW-5D (µg/L)
SEMI-VOLATILES						
1,2-Dichlorobenzene	0/10	10	NA	NA	NA	<10
1,2,4-Trichlorobenzene	0/10	10	NA	NA	NA	<10
1,3-Dichlorobenzene	0/10	10	NA	NA	NA	<10
1,4-Dichlorobenzene	0/10	10	NA	NA	NA	<10
2-Chloronaphthalene	0/10	10	NA	NA	NA	NA
2-Chlorophenol	0/10	10	NA	NA	NA	<10
2-Methylnaphthalene	0/10	10	NA	NA	NA	NA
2-Methylphenol	0/10	10	NA	NA	NA	<50
2-Nitroaniline	0/10	50	NA	NA	NA	NA
2-Nitrophenol	0/10	10	NA	NA	NA	NA
2,4-Dichlorophenol	0/10	10	NA	NA	NA	NA
2,4-Dimethylphenol	0/10	10	NA	NA	NA	NA
2,4-Dinitrophenol	0/10	50	NA	NA	NA	NA
2,4-Dinitrotoluene	0/10	10	NA	NA	NA	<10
2,4,6-Trichlorophenol	0/10	50	NA	NA	NA	NA
2,4,6-Trichlorophenol	0/10	10	NA	NA	NA	NA
2,6-Dinitrotoluene	0/10	10	NA	NA	NA	<10
3-Nitroaniline	0/10	50	NA	NA	NA	<50
3,3'-Dichlorobenzidine	2/10	20	20.0	11	20.0	<20
4-Bromophenyl-phenylether	0/10	10	NA	NA	NA	<10
4-Chloro-3-methylphenol	0/10	10	NA	NA	NA	NA
4-Chloroaniline	0/10	10	NA	NA	NA	<10
4-Chlorophenyl-phenylether	0/10	10	NA	NA	NA	<10
4-Methylphenol	0/10	10	NA	NA	NA	NA
4-Nitroaniline	0/10	50	NA	NA	NA	<50
4-Nitrophenol	0/10	50	NA	NA	NA	NA
4,6-dinitro-2-methylphenol	0/10	50	NA	NA	NA	NA
Acenaphthene	0/10	10	NA	NA	NA	<10
Acenaphthylene	0/10	10	NA	NA	NA	<10
Anthracene	0/10	10	NA	NA	NA	<10
Benzoic acid	0/10	50	NA	NA	NA	NA
Benzo(a)anthracene	0/10	10	NA	NA	NA	<10
Benzo(a)pyrene	0/10	10	NA	NA	NA	<10
Benzo(b)fluoranthene	0/10	10	NA	NA	NA	<10
Benzo(ghi)perylene	0/10	10	NA	NA	NA	<10
Benzo(k)fluoranthene	0/10	10	NA	NA	NA	<10
Benzyl Alcohol	0/10	10	NA	NA	NA	<10
Bis(2-chloroethoxy)methane	0/10	10	NA	NA	NA	<10
Bis(2-chloroethoxy) ether	0/10	10	NA	NA	NA	<10
Bis(2-chloroisopropoxy) ether	0/10	10	NA	NA	NA	<10
Bis(2-ethoxyethyl)phthalate	0/10	10	NA	NA	NA	<10
Butylbenzylphthalate	0/10	10	NA	NA	NA	<10
Chrysene	0/10	10	NA	NA	NA	<10
Dibenzofuran	0/10	10	NA	NA	NA	<10
Dibenzo(a,h)anthracene	0/10	10	NA	NA	NA	<10
Diethylphthalate	0/10	10	NA	NA	NA	<10
Dimethylphthalate	0/10	10	NA	NA	NA	<10
Di-n-butylphthalate	0/10	10	NA	NA	NA	<10
Di-n-octylphthalate	0/10	10	NA	NA	NA	<10
Fluoranthene	0/10	10	NA	NA	NA	<10
Fluorene	0/10	10	NA	NA	NA	<10
Hexachlorobenzene	0/10	10	NA	NA	NA	<10
Hexachlorobutadiene	0/10	10	NA	NA	NA	<10
Hexachlorocyclopentadiene	2/10	10	10.0	5	10	<10
Hexachloroethane	0/10	10	NA	NA	NA	<10
Indeno(123cd)pyrene	0/10	10	NA	NA	NA	<10
Isophorone	0/10	10	NA	NA	NA	<10
Naphthalene	0/10	10	NA	NA	NA	<10
Nitrobenzene	0/10	10	NA	NA	NA	<10
N-nitroso-di-n-propylamine	0/10	10	NA	NA	NA	<10
N-nitrosodiphenylamine	0/10	10	NA	NA	NA	<10
Pentachlorophenol	0/10	50	NA	NA	NA	NA
Phenanthrene	0/10	10	NA	NA	NA	<10
Phenol	0/10	10	NA	NA	NA	NA
Pyrene	0/10	10	NA	NA	NA	<10
PESTICIDES						
4,4'-DDD	0/11	0.1-0.11	NA	NA	NA	<0.11
4,4'-DDE	0/11	0.1-0.11	NA	NA	NA	<0.11
4,4'-DDT	0/11	0.1-0.11	NA	NA	NA	<0.11
Aldrin	0/11	0.05-0.06	NA	NA	NA	<0.063
Alpha-BHC	0/11	0.05-0.06	NA	NA	NA	<0.053
Alpha-chlorodane	0/11	0.5-0.056	NA	NA	NA	<0.53
Beta-BHC	0/11	0.05-0.06	NA	NA	NA	<0.063
Deltamethrin	0/11	0.1-0.11	NA	NA	NA	<0.11
Delta-BHC	0/11	0.05-0.06	NA	NA	NA	<0.063
Endosulfan I	0/11	0.05-0.06	NA	NA	NA	<0.063
Endosulfan II	0/11	0.1-0.11	NA	NA	NA	<0.11
Endosulfan Sulfate	0/11	0.1-0.11	NA	NA	NA	<0.11
Endrin	0/11	0.1-0.11	NA	NA	NA	<0.11
Endrin ketone	0/11	0.1-0.11	NA	NA	NA	<0.11
Gamma-BHC	0/11	0.05-0.06	NA	NA	NA	<0.063
Gamma-chlorodane	0/11	0.5-0.056	NA	NA	NA	<0.53
Heptachlor	0/11	0.05-0.06	NA	NA	NA	<0.063
Heptachlor epoxide	0/11	0.05-0.06	NA	NA	NA	<0.063
Methoxychlor	0/11	0.5-0.056	NA	NA	NA	<0.53
Toxaphene	0/11	1-1.1	NA	NA	NA	<1.1
PCB's						
Aroclor-1018	0/11	0.5-0.56	NA	NA	NA	<0.53
Aroclor-1221	0/11	0.5-0.56	NA	NA	NA	<0.53
Aroclor-1232	0/11	0.5-0.56	NA	NA	NA	<0.53
Aroclor-1242	0/11	0.5-0.56	NA	NA	NA	<0.53
Aroclor-1248	0/11	0.5-0.56	NA	NA	NA	<0.53
Aroclor-1254	0/11	1-1.1	NA	NA	NA	<1.0
Aroclor-1260	0/11	1-1.1	NA	NA	NA	<1.0

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA Not Applicable

TABLE 5-4
SUMMARY OF SURFACE WATER DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN OF CONCENTRATION (µg/L)	MAXIMUM CONCENTRATION (µg/L)
INORGANICS					
Aluminum	2/6	84-383	150-370	114.1	370
Antimony	0/6	22-30.8	NA	NA	NA
Arsenic	3/6	2	2	1.4	2
Barium	4/6	16.6-59.4	10.8-12.4	12.5	12.4
Beryllium	0/6	1	NA	NA	NA
Cadmium	2/6	3	3.0-3.3	1.9	3.3
Calcium	6/6	(5.0) ^a	19100-30000	21348	30000
Chromium	1/6	2	4	1.3	4
Cobalt	0/6	8.1	NA	NA	NA
Copper	0/6	6.0-28.5	NA	NA	NA
Cyanide	0/6	10	NA	NA	NA
Iron	6/6	(0.1) ^a	365-18000	1695	18000
Lead	3/6	3	3-3.8	2.3	3.8
Magnesium	6/6	(5.0) ^a	2370-18100	7607	18100
Manganese	6/6	(0.015) ^a	22.6-1930	170.6	1930
Mercury	0/6	0.2	NA	NA	NA
Nickel	0/6	7.0-18.5	NA	NA	NA
Potassium	5/6	1840	2820-11000	3189	11000
Selenium	3/6	2	3.1	1.5	3.1
Silver	0/6	3-7.9	NA	NA	NA
Sodium	6/6	(5.0) ^a	5730-17900	18054	17900
Thallium	4/6	4	1	1.3	1
Vandium	1/6	10.3-12.5	5	5.1	5
Zinc	2/6	16.7-37.5	325-1190	45.6	1190
VOLATILES					
1,1-Dichloroethane	0/6	5	NA	NA	NA
1,1-Dichloroethene	0/6	5	NA	NA	NA
1,1,1-Trichloroethane	0/6	5	NA	NA	NA
1,1,2-Trichloroethane	0/6	5	NA	NA	NA
1,1,2,2-Tetrachloroethane	0/6	5	NA	NA	NA
1,2-Dichloroethane	0/6	5	NA	NA	NA
1,2-Dichloroethene	0/6	5	NA	NA	NA
1,2-Dichloropropane	0/6	5	NA	NA	NA
1,3-Dichloropropene (Cis)	0/6	5	NA	NA	NA
1,3-Dichloropropene (Trans)	0/6	5	NA	NA	NA
2-Butanone	0/6	10	NA	NA	NA
2-Hexanone	0/6	10	NA	NA	NA
4-Methyl-2-Pentanone	0/6	10	NA	NA	NA
Acetone	1/6	8-10	10	4.9	10
Benzene	0/6	5	NA	NA	NA
Bromodichloromethane	0/6	5	NA	NA	NA
Bromoform	0/6	5	NA	NA	NA
Bromomethane	0/6	10	NA	NA	NA
Carbon disulfide	2/6	2-5	4-26	3.4	26
Carbon Tetrachloride	1/6	5	3	2.6	3
Chlorobenzene	0/6	5	NA	NA	NA
Chloroethane	0/6	10	NA	NA	NA
Chloroform	0/6	5	NA	NA	NA
Chloromethane	1/6	10	5	5.6	5
Dibromochloromethane	0/6	5	NA	NA	NA
Ethylbenzene	0/6	5	NA	NA	NA
Methylene chloride	0/6	2-5	NA	NA	NA
Styrene	0/6	5	NA	NA	NA
Tetrachloroethene	0/6	5	NA	NA	NA
Toluene	0/6	5	NA	NA	NA
Trichloroethene	0/6	5	NA	NA	NA
Vinyl acetate	1/6	10	10	5.6	10
Vinyl chloride	0/6	10	NA	NA	NA
Xylenes	0/6	5	NA	NA	NA

^a SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA Not Applicable

TABLE 5-4 (cont.)
SUMMARY OF SURFACE WATER DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN OF CONCENTRATION (µg/L)	MAXIMUM CONCENTRATION (µg/L)
SEMI-VOLATILES					
1,2-Dichlorobenzene	0/6	10-12	NA	NA	NA
1,2,4-Trichlorobenzene	0/6	10-12	NA	NA	NA
1,3-Dichlorobenzene	0/6	10-12	NA	NA	NA
1,4-Dichlorobenzene	0/6	10-12	NA	NA	NA
2-Chloronaphthalene	0/6	10-12	NA	NA	NA
2-Chlorophenol	0/6	10-12	NA	NA	NA
2-Methylnaphthalene	0/6	10-12	NA	NA	NA
2-Methylphenol	0/6	10-12	NA	NA	NA
2-Nitroaniline	0/6	50-60	NA	NA	NA
2-Nitrophenol	0/6	10-12	NA	NA	NA
2,4-Dichlorophenol	0/6	10-12	NA	NA	NA
2,4-Dimethylphenol	0/6	10-12	NA	NA	NA
2,4-Dinitrophenol	0/6	50-60	NA	NA	NA
2,4-Dinitrotoluene	0/6	10-12	NA	NA	NA
2,4,5-Trichlorophenol	0/6	50-60	NA	NA	NA
2,4,6-Trichlorophenol	0/6	10-12	NA	NA	NA
2,6-Dinitrotoluene	0/6	10-12	NA	NA	NA
3-Nitroaniline	0/6	50-60	NA	NA	NA
3,3'-Dichlorobenzidine	0/6	20-24	NA	NA	NA
4-Bromophenyl-phenylether	0/6	10-12	NA	NA	NA
4-Chloro-3-methylphenol	0/6	10-12	NA	NA	NA
4-Chloroaniline	0/6	10-12	NA	NA	NA
4-Chlorophenyl-phenylether	0/6	10-12	NA	NA	NA
4-Methylphenol	0/6	10-12	NA	NA	NA
4-Nitroaniline	1/6	50-60	55	30	56
4-Nitrophenol	0/6	50-60	NA	NA	NA
4,6-dinitro-2-methylphenol	0/6	50-60	NA	NA	NA
Acenaphthene	0/6	10-12	NA	NA	NA
Acenaphthylene	0/6	10-12	NA	NA	NA
Anthracene	0/6	10-12	NA	NA	NA
Benzoic acid	0/6	50-60	NA	NA	NA
Benzo(a)anthracene	0/6	10-12	NA	NA	NA
Benzo(a)pyrene	0/6	10-12	NA	NA	NA
Benzo(b)fluoranthene	0/6	10-12	NA	NA	NA
Benzo(ghi)perylene	0/6	10-12	NA	NA	NA
Benzo(k)fluoranthene	0/6	10-12	NA	NA	NA
Benzyl Alcohol	0/6	10-12	NA	NA	NA
Bis(2-chloroethoxy)methane	0/6	10-12	NA	NA	NA
Bis(2-chloroethoxy)ether	0/6	10-12	NA	NA	NA
Bis(2-chloroisopropyl)ether	0/6	10-12	NA	NA	NA
Bis(2-ethylhexyl)phthalate	1/6	11-12	2	3	2
Butylbenzylphthalate	0/6	10-12	NA	NA	NA
Chrysene	0/6	10-12	NA	NA	NA
Dibenzofuran	0/6	10-12	NA	NA	NA
Dibenzo(a,h)anthracene	0/6	10-12	NA	NA	NA
Diethylphthalate	0/6	10-12	NA	NA	NA
Dimethylphthalate	0/6	10-12	NA	NA	NA
Di-n-butylphthalate	1/6	10-12	1	4	1
Di-n-octylphthalate	0/6	10-12	NA	NA	NA
Fluoranthene	0/6	10-12	NA	NA	NA
Fluorene	0/6	10-12	NA	NA	NA
Hexachlorobenzene	0/6	10-12	NA	NA	NA
Hexachlorobutadiene	0/6	10-12	NA	NA	NA
Hexachlorocyclopentadiene	0/6	10-12	NA	NA	NA
Hexachloroethane	0/6	10-12	NA	NA	NA
Indeno(123cd)pyrene	0/6	10-12	NA	NA	NA
Isophorone	0/6	10-12	NA	NA	NA
Naphthalene	0/6	10-12	NA	NA	NA
Nitrobenzene	0/6	10-12	NA	NA	NA
N-nitroso-di-n-propylamine	0/6	10-12	NA	NA	NA
N-nitrosodiphenylamine	0/6	10-12	NA	NA	NA
Pentachlorophenol	0/6	50-60	NA	NA	NA
Phenanthrene	0/6	10-12	NA	NA	NA
Phenol	1/6	10-12	4	5	4
Pyrene	0/6	10-12	NA	NA	NA
PESTICIDES					
4,4'-DDD	0/4	0.10	NA	NA	NA
4,4'-DDE	0/4	0.10	NA	NA	NA
4,4'-DDT	0/4	0.10	NA	NA	NA
Aldrin	0/4	0.050	NA	NA	NA
Alpha-BHC	0/4	0.050	NA	NA	NA
Alpha-chlorodane	0/4	0.50	NA	NA	NA
Beta-BHC	0/4	0.050	NA	NA	NA
Delidrin	0/4	0.01	NA	NA	NA
Delta-BHC	0/4	0.050	NA	NA	NA
Endosulfan I	0/4	0.050	NA	NA	NA
Endosulfan II	0/4	0.10	NA	NA	NA
Endosulfan Sulfate	0/4	0.10	NA	NA	NA
Endrin	0/4	0.10	NA	NA	NA
Endrin ketone	0/4	0.10	NA	NA	NA
Gamma-BHC	0/4	0.050	NA	NA	NA
Gamma-chlorodane	0/4	0.50	NA	NA	NA
Heptachlor	0/4	0.050	NA	NA	NA
Heptachlor epoxide	0/4	0.050	NA	NA	NA
Methoxychlor	0/4	0.50	NA	NA	NA
Toxaphene	0/4	1	NA	NA	NA
PCB's					
Aroclor-1016	0/5	0.50	NA	NA	NA
Aroclor-1221	0/5	0.50	NA	NA	NA
Aroclor-1232	0/5	0.50	NA	NA	NA
Aroclor-1242	0/5	0.50	NA	NA	NA
Aroclor-1248	0/5	0.50	NA	NA	NA
Aroclor-1254	0/5	1	NA	NA	NA
Aroclor-1260	0/5	1	NA	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA Not Applicable

TABLE 5-5
SUMMARY OF SEDIMENT DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)
INORGANICS					
Aluminum	6/6	(0.2)a	6370-10300	8894	10300
Antimony	6/6	(0.06)a	4.8-6.4	5.7	6.4
Arsenic	6/6	(0.01)a	7.05-21.1	10.9	21.1
Barium	6/6	(0.2)a	5.6-28.9	13.2	28.9
Beryllium	1/6	0.25-0.29	46	0.16	0.46
Cadmium	0/6	0.66-0.87	NA	NA	NA
Calcium	6/6	(5.0)a	274.9-666	536.6	666
Chromium	6/6	(0.01)a	12-25.9	14.7	25.9
Cobalt	6/6	(0.06)a	12.5-16.1	14.4	16.1
Copper	6/6	(0.025)a	11.6-16.1	13.5	16.1
Cyanide	0/6	0.55-0.73	NA	NA	NA
Iron	6/6	(0.1)a	23500-41100	30726	41100
Lead	6/6	(0.005)a	5.2-16.4	8.62	16.4
Magnesium	6/6	(5.0)a	2110-3250	2752	3250
Manganese	6/6	(0.015)a	178-396	232.3	396
Mercury	0/6	0.11-0.15	NA	NA	NA
Nickel	0/6	21.2-35.5	NA	NA	NA
Potassium	3/6	159-209	236-275	171.4	275
Selenium	1/6	(0.005)a	0.66	0.66	0.66
Silver	0/6	0.79-1.1	NA	NA	NA
Sodium	0/6	23.2-314	NA	NA	NA
Thallium	2/6	0.5-0.6	0.41-0.55	NA	NA
Vanadium	0/6	18.7-26.5	NA	NA	NA
Zinc	4/6	75.8-104	56.1-72.7	66.5	72.7
VOLATILES					
1,1-Dichloroethane	0/6	0.005-0.006	NA	NA	NA
1,1-Dichloroethene	0/6	0.005-0.006	NA	NA	NA
1,1,1-Trichloroethane	2/6	0.005-0.006	0.006	0.0036	0.006
1,1,2-Trichloroethane	2/6	0.005-0.006	0.006	0.0036	0.006
1,1,2,2-Tetrachloroethane	2/6	0.005-0.006	0.006	0.0036	0.006
1,2-Dichloroethane	0/6	0.005-0.006	NA	NA	NA
1,2-Dichloroethene	0/6	0.005-0.006	NA	NA	NA
1,2-Dichloropropane	2/6	0.005-0.006	0.006	0.0036	0.006
1,3-Dichloropropene (Cis)	2/6	0.005-0.006	0.006	0.0036	0.006
1,3-Dichloropropene (Trans)	2/6	0.005-0.006	0.006	0.0036	0.006
2-Butanone	0/6	(0.01)a	NA	NA	NA
2-Hexanone	2/6	0.01-0.013	0.0115-0.012	0.0073	0.012
4-Methyl-2-Pentanone	2/6	0.01-0.013	0.0115-0.012	0.0073	0.012
Acetone	0/6	0.009-0.046	NA	NA	NA
Benzene	2/6	0.005-0.006	0.006	0.0036	0.006
Bromodichloromethane	2/6	0.005-0.006	0.006	0.0036	0.006
Bromoform	2/6	0.005-0.006	0.006	0.0036	0.006
Bromomethane	0/6	0.01-0.013	NA	NA	NA
Carbon disulfide	0/6	0.002-0.006	NA	NA	NA
Carbon Tetrachloride	2/6	0.005-0.006	0.006	0.0036	0.006
Chlorobenzene	2/6	0.005-0.006	0.006	0.0036	0.006
Chloroethane	0/6	0.01-0.013	NA	NA	NA
Chloroform	0/6	0.005-0.006	NA	NA	NA
Chloromethane	0/6	0.01-0.013	NA	NA	NA
Dibromochloromethane	2/6	0.005-0.006	0.006	0.0036	0.006
Ethylbenzene	2/6	0.005-0.006	0.006	0.0036	0.006
Methylene chloride	0/6	0.006-0.012	NA	NA	NA
Styrene	2/6	0.005-0.006	0.006	0.0036	0.006
Tetrachloroethene	2/6	0.005-0.006	0.006	0.0036	0.006
Toluene	2/6	0.005-0.006	0.006	0.0036	0.006
Trichloroethene	2/6	0.005-0.006	0.006	0.0036	0.006
Vinyl acetate	2/6	0.01-0.013	0.0115-0.012	0.0073	0.012
Vinyl chloride	0/6	0.01-0.013	NA	NA	NA
Xylenes	2/6	0.005-0.006	0.006	0.0036	0.006

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA Not Applicable

TABLE 6-5 (cont)
SUMMARY OF SEDIMENT DATA
FOR TANK FARM 4

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN OF CONCENTRATION (mg/kg)	MAXIMUM CONCENTRATION (mg/kg)
SEMI-VOLATILES					
1,2-Dichlorobenzene	0/6	0.43-0.515	NA	NA	NA
1,2,4-Trichlorobenzene	0/6	0.43-0.515	NA	NA	NA
1,3-Dichlorobenzene	0/6	0.43-0.515	NA	NA	NA
1,4-Dichlorobenzene	0/6	0.43-0.515	NA	NA	NA
2-Chloronaphthalene	0/6	0.43-0.515	NA	NA	NA
2-Chlorophenol	0/6	0.43-0.515	NA	NA	NA
2-Methylnaphthalene	0/6	0.43-0.515	NA	NA	NA
2-Methylphenol	0/6	0.43-0.515	NA	NA	NA
2-Nitroaniline	0/6	2.2-2.55	NA	NA	NA
2-Nitrophenol	0/6	0.43-0.515	NA	NA	NA
2,4-Dichlorophenol	0/6	0.43-0.515	NA	NA	NA
2,4-Dimethylphenol	0/6	0.43-0.515	NA	NA	NA
2,4-Dinitrophenol	0/6	2.2-2.55	NA	NA	NA
2,4-Dinitrotoluene	0/6	0.43-0.515	NA	NA	NA
2,4,5-Trichlorophenol	0/6	2.2-2.55	NA	NA	NA
2,4,6-Trichlorophenol	0/6	0.43-0.515	NA	NA	NA
2,6-Dinitrotoluene	0/6	0.43-0.515	NA	NA	NA
3-Nitroaniline	0/6	2.2-2.55	NA	NA	NA
3,3'-Dichlorobenzidine	1/6	0.9-1	0.86	0.522	0.86
4-Bromophenyl-phenylether	0/6	0.43-0.515	NA	NA	NA
4-Chloro-3-methylphenol	0/6	0.43-0.515	NA	NA	NA
4-Chloroaniline	0/6	0.43-0.515	NA	NA	NA
4-Chlorophenyl-phenylether	0/6	0.43-0.515	NA	NA	NA
4-Methylphenol	0/6	0.43-0.515	NA	NA	NA
4-Nitroaniline	0/6	2.2-2.55	NA	NA	NA
4-Nitrophenol	0/6	2.2-2.55	NA	NA	NA
4,6-dinitro-2-methylphenol	0/6	2.2-2.55	NA	NA	NA
Acenaphthene	0/6	0.43-0.515	NA	NA	NA
Acenaphthylene	0/6	0.43-0.515	NA	NA	NA
Anthracene	0/6	0.43-0.515	NA	NA	NA
Benzoic acid	1/6	2.2-2.5	1.355	1.1808	1.355
Benzo(a)anthracene	1/6	0.45-0.515	0.43	0.262	0.43
Benzo(a)pyrene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Benzo(b)fluoranthene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Benzo(ghi)perylene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Benzo(k)fluoranthene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Benzyl Alcohol	0/6	0.43-0.515	NA	NA	NA
Bis(2-chloroethoxy)methane	0/6	0.43-0.515	NA	NA	NA
Bis(2-chloroethyl)ether	0/6	0.43-0.515	NA	NA	NA
Bis(2-chloroisopropyl)ether	0/6	0.43-0.515	NA	NA	NA
Bis(2ethylhexyl)phthalate	1/6	0.074-0.515	0.43	0.177	0.43
Butylbenzylphthalate	1/6	0.45-0.515	0.43	0.262	0.43
Chrysene	1/6	0.45-0.515	0.43	0.262	0.43
Dibenzofuran	0/6	0.43-0.515	NA	NA	NA
Dibenzo(a,h)anthracene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Diethylphthalate	0/6	0.43-0.515	NA	NA	NA
Dimethylphthalate	0/6	0.43-0.515	NA	NA	NA
Di-n-butylphthalate	1/6	0.43-0.49	0.595	0.268	0.595
Di-n-octylphthalate	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Fluoranthene	0/6	0.43-0.515	NA	NA	NA
Fluorene	0/6	0.43-0.515	NA	NA	NA
Hexachlorobenzene	0/6	0.43-0.515	NA	NA	NA
Hexachlorobutadiene	0/6	0.43-0.515	NA	NA	NA
Hexachlorocyclopentadiene	0/6	0.43-0.515	NA	NA	NA
Hexachloroethane	0/6	0.43-0.515	NA	NA	NA
Indeno(123cd)pyrene	2/6	0.45-0.515	0.43-0.45	0.294	0.45
Isophorone	0/6	0.43-0.515	NA	NA	NA
Naphthalene	0/6	0.43-0.515	NA	NA	NA
Nitrobenzene	0/6	0.43-0.515	NA	NA	NA
N-nitroso-di-n-propylamine	0/6	0.43-0.515	NA	NA	NA
N-nitrosodiphenylamine	0/6	0.43-0.515	NA	NA	NA
Pentachlorophenol	0/6	2.2-2.55	NA	NA	NA
Phenanthrene	0/6	0.43-0.515	NA	NA	NA
Phenol	0/6	0.43-0.515	NA	NA	NA
Pyrene	1/6	0.45-0.515	0.43	0.262	0.43
PESTICIDES					
4,4'-DDD	0/6	0.019-0.022	NA	NA	NA
4,4'-DDE	0/6	0.019-0.022	NA	NA	NA
4,4'-DDT	1/6	0.019-0.021	12.4	0.010	0.0124
Aldrin	0/6	0.0093-0.011	NA	NA	NA
Alpha-BHC	0/6	0.0093-0.011	NA	NA	NA
Alpha-chlorodane	0/6	0.093-0.11	NA	NA	NA
Beta-BHC	0/6	0.0093-0.011	NA	NA	NA
Delidrin	0/6	0.019-0.022	NA	NA	NA
Delta-BHC	0/6	0.0093-0.011	NA	NA	NA
Endosulfan I	0/6	0.0093-0.011	NA	NA	NA
Endosulfan II	0/6	0.019-0.022	NA	NA	NA
Endosulfan Sulfate	0/6	0.019-0.022	NA	NA	NA
Endrin	0/6	0.019-0.022	NA	NA	NA
Endrin ketone	0/6	0.019-0.022	NA	NA	NA
Gamma-BHC	0/6	0.0093-0.011	NA	NA	NA
Gamma-chlorodane	0/6	0.093-0.11	NA	NA	NA
Heptachlor	0/6	0.0093-0.011	NA	NA	NA
Heptachlor epoxide	0/6	0.0093-0.011	NA	NA	NA
Methoxychlor	0/6	0.093-0.11	NA	NA	NA
Toxaphene	0/6	0.19-0.22	NA	NA	NA
PCB's					
Aroclor-1016	0/6	0.093-0.11	NA	NA	NA
Aroclor-1221	0/6	0.093-0.11	NA	NA	NA
Aroclor-1232	0/6	0.093-0.11	NA	NA	NA
Aroclor-1242	0/6	0.093-0.11	NA	NA	NA
Aroclor-1248	0/6	0.093-0.11	NA	NA	NA
Aroclor-1254	0/6	0.19-0.22	NA	NA	NA
Aroclor-1260	0/6	0.19-0.22	NA	NA	NA

a. SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA Not Applicable

TABLE 6-8
SUMMARY OF CONTAMINANTS
TANK FARM 4

COMPOUND NAME		RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (ug/L)	RANGE OF SEDIMENT SAMPLES (mg/kg)	RANGE OF SURFACE WATER SAMPLES (ug/L)
INORGANICS						
Aluminum	&*	2110-12200	1010-11700	84-251000	6370-10300	150-370
Antimony	&*	X 3.5-4.7	5.6-8.7	ND	X 4.6-6.4	ND
Arsenic	&***	8.6-6.5	3.2-18.7	2-448	7.06-21.1	X 2
Barium	&*	16.5-32.8	5.6-21.9	5-676	5.6-26.9	10.8-12.4
Beryllium	&*	0.2-0.52	0.27-0.47	7.2-8.5	46	ND
Cadmium	&*	ND	ND	3-8.5	ND	3.0-3.3
Calcium	&	633-1030	143-1620	8050-88800	274.9-885	19100-30000
Chromium	&***	3.7-15.1	3.8-19.1	4-391	12-25.9	4
Cobalt	&*	12.5-19.3	11.7-22	8.6-889	12.5-18.1	ND
Copper	&***	13.6-25.8	13.8-35.2	5.1-589	11.6-18.1	ND
Cyanide	&	ND	ND	ND	ND	ND
Iron	&*	10600-41100	18400-41000	3450-98200	23500-41100	365-18000
Lead	&*	11.5-40	4.1-11.9	3-156	5.2-16.4	3-3.8
Magnesium	&	881-2610	409-4480	9220-98200	2110-3250	2370-18100
Manganese	&***	108-471	308-642.5	565-11500	178-396	22.6-1930
Mercury	&*	0.13	ND	ND	ND	ND
Nickel	&***	18.5-27.2	14.6-37.7	81.5-749	ND	ND
Potassium	&	182-253	428	723-12800	238-275	2920-11000
Selenium	&***	ND	0.31-0.41	X 2.0-20.0	0.88	3.1
Silver	&	ND	0.625	3-30.8	ND	ND
Sodium	&	ND	ND	2280-27700	ND	6730-17900
Thallium	&***	X 0.68-0.88	0.61-0.88	X 4-40	X 0.41-0.65	X 1
Vanadium	&	17.9-18.1	11.1-20.7	114-168	ND	5
Zinc	&*	58.9-83.4	49.3-103	80.6-1480	58.1-72.7	325-1190
VOLATILES						
1,1-Dichloroethane		ND	ND	ND	ND	ND
1,1-Dichloroethane		ND	ND	ND	ND	ND
1,1,1-Trichloroethane	&	X 0.006	ND	ND	X 0.006	ND
1,1,2-Trichloroethane	&	X 0.008	ND	ND	X 0.006	ND
1,1,2,2-Tetrachloroethane	&	X 0.008	ND	ND	X 0.006	ND
1,2-Dichloroethane		ND	ND	ND	ND	ND
1,2-Dichloroethane		ND	ND	ND	ND	ND
1,2-Dichloropropane	&	X 0.006	ND	ND	X 0.006	ND
1,3-Dichloropropene (Cis)	&	X 0.006	ND	ND	X 0.006	ND
1,3-Dichloropropene (Trans)	&	X 0.006	ND	ND	X 0.006	ND
2-Butanone		ND	ND	ND	ND	ND
2-Hexanone		X 0.013-1.2	ND	ND	X 0.0115-0.012	ND
4-Methyl-2-Pentanone		X 0.013-1.2	ND	ND	X 0.0115-0.012	ND
Acetone		ND	ND	ND	ND	10
Benzene	&***	X 0.006	ND	ND	X 0.006	ND
Bromodichloromethane	&	X 0.006	ND	ND	X 0.006	ND
Bromofom	&	X 0.006	ND	ND	X 0.006	ND
Bromomethane		ND	ND	ND	ND	ND
Carbon disulfide	&	X 0.006-0.025	ND	ND	ND	4-26
Carbon Tetrachloride	&*	X 0.006	ND	ND	X 0.006	3
Chlorobenzene		X 0.006	ND	ND	X 0.006	ND
Chloroethane		ND	ND	ND	ND	ND
Chloroform		ND	ND	ND	ND	ND
Chloromethane		ND	ND	ND	ND	5
Dibromochloromethane	&	X 0.006	ND	ND	X 0.006	ND
Ethylbenzene		X 0.006	ND	ND	X 0.006	ND
Methylene chloride		ND	ND	ND	ND	ND
Styrene	&*	X 0.006	ND	ND	X 0.006	ND
Tetrachloroethane	&*	0.002-0.88	0.002	ND	X 0.006	ND
Toluene		0.006	0.001-0.002	ND	X 0.006	ND
Trichloroethane	&	X 0.006	ND	ND	X 0.006	ND
Vinyl acetate		X 0.012-0.8	ND	ND	X 0.0115-0.012	10
Vinyl Chloride		ND	ND	ND	ND	ND
Xylenes		X 0.006	ND	ND	X 0.006	ND

& Included as chemicals of potential concern for this site

* Risk addressed quantitatively only

** Risk addressed qualitatively only

*** Risk addressed both quantitatively and qualitatively

X Values "UJ" qualified data only

ND Not Detected

TABLE 5-8 (cont.)
SUMMARY OF CONTAMINANTS
TANK FARM 4

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (ug/L)	RANGE OF SEDIMENT SAMPLES (mg/kg)	RANGE OF SURFACE WATER SAMPLES (ug/L)
SEMIVOLATILES					
1,2-Dichlorobenzene	X 0.5	X 0.38	ND	ND	ND
1,2,4-Trichlorobenzene	X 0.5	X 0.38	ND	ND	ND
1,3-Dichlorobenzene	X 0.5	X 0.38	ND	ND	ND
1,4-Dichlorobenzene	& X 0.5	X 0.38	ND	ND	ND
2-Chloronaphthalene	X 0.5	X 0.38	ND	ND	ND
2-Chlorophenol	X 0.5	X 0.38	ND	ND	ND
2-Methylnaphthalene	& X 0.19	X 0.38	ND	ND	ND
2-Methylphenol	X 0.5	X 0.38	ND	ND	ND
2-Nitroaniline	X 2.5	X 1.9	ND	ND	ND
2-Nitrophenol	X 0.5	X 0.38	ND	ND	ND
2,4-Dichlorophenol	X 0.5	X 0.38	ND	ND	ND
2,4-Dimethylphenol	X 0.5	X 0.38	ND	ND	ND
2,4-Dinitrophenol	X 2.5	X 1.9	ND	ND	ND
2,4-Dinitrotoluene	X 0.5	X 0.38	ND	ND	ND
2,4,5-Trichlorophenol	& X 2.5	X 1.9	ND	ND	ND
2,4,6-Trichlorophenol	& X 0.5	X 0.38	ND	ND	ND
2,6-Dinitrotoluene	& X 0.5	X 0.38	ND	ND	ND
3-Nitroaniline	X 0.5	X 1.9	ND	ND	ND
3,3'-Dichlorobenzidine	& X 1.0	X 0.77	X 20.0	X 0.86	ND
4-Bromophenyl-phenylether	X 0.5	X 0.38	ND	ND	ND
4-Chloro-3-methylphenol	X 0.5	X 0.38	ND	ND	ND
4-Chloroaniline	X 0.5	X 0.38	ND	ND	ND
4-Chlorophenyl-phenylether	X 0.5	X 0.38	ND	ND	ND
4-Methylphenol	X 0.5	X 0.38	ND	ND	ND
4-Nitroaniline	X 2.5	X 1.9-2.0	ND	ND	55
4-Nitrophenol	X 2.5	X 1.9	ND	ND	ND
4,6-dinitro-2-methylphenol	X 2.5	X 1.9	ND	ND	ND
Acenaphthene	& X 0.078	X 0.38	ND	ND	ND
Acenaphthylene	X 0.5	X 0.38	ND	ND	ND
Anthracene	& X 0.13	X 0.38	ND	ND	ND
Benzoic acid	X 2.5	X 1.9	ND	1 355	ND
Benzo(a)anthracene	& X 0.1-0.16	X 0.38	ND	X 0.43	ND
Benzo(a)pyrene	& X 0.075	X 0.38	ND	X 0.43-0.45	ND
Benzo(b)fluoranthene	& X 0.085	X 0.38	ND	X 0.43-0.45	ND
Benzo(g,h,i)perylene	ND	X 0.38	ND	X 0.43-0.45	ND
Benzo(k)fluoranthene	ND	X 0.38	ND	X 0.43-0.45	ND
Benzyl Alcohol	X 0.5	X 0.38	ND	ND	ND
Bis(2-chloroethoxy)methane	X 0.5	X 0.38	ND	ND	ND
Bis(2-chloroethyl)ether	& X 0.5	X 0.38	ND	ND	ND
Bis(2-chloroisopropyl)ether	X 0.5	X 0.38	ND	ND	ND
Bis(2-ethylhexyl)phthalate	& X 6.8	ND	ND	X 0.43	2
Butylbenzylphthalate	& X 0.5	X 0.38	ND	X 0.43	ND
Chrysene	& X 0.12-9.6	X 0.38	ND	X 0.43	ND
Dibenzofuran	X 0.5	X 0.38	ND	ND	ND
Dibenz(a,h)anthracene	& X 0.06	X 0.38	ND	X 0.43-0.45	ND
Diethylphthalate	X 0.5	X 0.38	ND	ND	ND
Dimethylphthalate	X 0.5	X 0.38	ND	ND	ND
Di-n-butylphthalate	& X 0.06	X 0.38	ND	0.595	1
Di-n-octylphthalate	ND	X 0.38	ND	X 0.43-0.45	ND
Fluoranthene	& X 0.13-0.25	X 0.38	ND	ND	ND
Fluorene	& X 0.19	X 0.38	ND	ND	ND
Hexachlorobenzene	& X 0.5	X 0.38	ND	ND	ND
Hexachlorobutadiene	& X 0.5	X 0.38	ND	ND	ND
Hexachlorocyclopentadiene	X 0.5	X 0.38	X 10.0	ND	ND
Hexachloroethane	& X 0.5	X 0.38	ND	ND	ND
Indeno(1,2,3-cd)pyrene	& X 0.05	X 0.38	ND	X 0.43-0.45	ND
Isophorone	& X 0.5	X 0.38	ND	ND	ND
Naphthalene	& X 0.5	X 0.38	ND	ND	ND
Nitrobenzene	& X 0.5	X 0.38	ND	ND	ND
N-nitroso-di-n-propylamine	& X 0.5	X 0.38	ND	ND	ND
N-nitrosodiphenylamine	& X 0.5	X 0.38	ND	ND	ND
Pentachlorophenol	& X 2.5	X 1.9	ND	ND	ND
Phenanthrene	& X 0.12-7.3	X 0.38	ND	ND	ND
Phenol	& X 0.052-0.15	X 0.38	ND	ND	4
Pyrene	& X 0.48-6.0	X 0.38	ND	X 0.43	ND
PESTICIDES					
2,4-D	X 0.0021-0.0024				
2,4,5-T	X 0.0011-0.0012				
2,4,5-TP (Silvex)	X 0.0011-0.0012				
4,4'-DDD	& ND	ND	ND	ND	ND
4,4'-DDE	& X 0.0045	ND	ND	ND	ND
4,4'-DDT	& X 0.0045	0.017	ND	12.4	ND
Aldrin	& X 0.0045	0.003	ND	ND	ND
Alpha-BHC	& X 0.0045	ND	ND	ND	ND
Alpha-chlorodane	& X 0.0045	ND	ND	ND	ND
Beta-BHC	& X 0.0045	ND	ND	ND	ND
Deltrin	& X 0.0045	0.01	ND	ND	ND
Delta-BHC	& X 0.0045	ND	ND	ND	ND
Endosulfan I	& X 0.0045	ND	ND	ND	ND
Endosulfan II	& X 0.0045	ND	ND	ND	ND
Endosulfan Sulfate	& X 0.0045	ND	ND	ND	ND
Endrin	X 0.00021	0.0082	ND	ND	ND
Endrin ketone	X 0.00021	ND	ND	ND	ND
Gamma-BHC	X 0.00011	ND	ND	ND	ND
Gamma-chlorodane	X 0.00011	ND	ND	ND	ND
Heptachlor	& X 0.00011	0.003	ND	ND	ND
Heptachlor epoxide	& X 0.00011	ND	ND	ND	ND
Methoxychlor	X 0.0021	ND	ND	ND	ND
Toxaphene	X 0.0021	ND	ND	ND	ND
PCB's					
Aroclor-1016	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND

& Included as chemicals of potential concern for this site
 * Risk addressed quantitatively only
 ** Risk addressed qualitatively only
 *** Risk addressed both quantitatively and qualitatively
 X Values "U" qualified data only
 ND Not Detected

TABLE 5-7
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE – TANK FARM FOUR

PARAMETER	VALUE OR RANGE	VALUE USED	RATIONALE	REFERENCE
Global variables				
Body Weight (kg)				
Children				
– scenario 1	25–61 2	43 2	Value based on average of males and females between 6–18 yrs	EPA 1991
– scenario 4	11 6–17 4	14 5	Value based on average of males and females between 0–6 yrs	EPA 1991
Adult	67 2–74 5	70	Value based on adult body weight	EPA 1991
Exposure Duration (years)				
– scenario 1 (children)	1–18	12	Based upon the age range of children with access to site	
– scenario 1 (adults)	1–52	30	National upper-bound (90th percentile) at one residence	
– scenario 2 (adults)	1–52	1	Amount of time spent building an industrial facility	EPA 1991
– scenario 3 (adults)	1–52	25	National upper-bound (90th percentile) at one job.	EPA 1991
– scenario 4 (children)	1–18	6	Duration for most exposed group (0–6 yr old)	EPA 1991
– scenario 4 (adult)	1–52	30	National upper-bound (90th percentile) at one residence	EPA 1991
Averaging Time				
Cancer– risks (days)	NA	25,550	Value based upon 70 year life expectancy.	EPA 1989
Noncancer– risks (days)				
– scenario 1 (children)	365–6570	4380	Value based upon exposure duration	
– scenario 1 (adults)	365–18980	10950	Value based upon exposure duration	
– scenario 2 (adults)	250–18980	250	Value based upon exposure duration	
– scenario 3 (adults)	250–18980	9125	Value based upon exposure duration.	
– scenario 4 (children)	365–6570	2190	Value based upon exposure duration.	
– scenario 4 (adults)	365–18980	10950	Value based upon exposure duration.	
Dermal Soil Contact Rate (mg/day)	500–1000	500	Adherence=0.5mg/cm ² , skin s.a.=2000cm ² ; fraction exposed=50%	EPA 1989a
Absorption Factor				
– Dermal				
VOC's	0–1	0.5		EPA, 1989a
PAHs/PCBs	0–1	0.05		EPA, 1989a
Inorganics	0–1	negligible		EPA, 1989a
Pesticides	0–1	0.05, 0.5	High; Low soil sorption, respectively	EPA, 1989a
– Ingestion				
VOC's, PAHs	0–1	1		EPA, 1989a
Inorganics	0–1	1		EPA, 1989a
Pesticides	0–1	0.3, 1	High; Low soil sorption, respectively	EPA, 1989a
Lead	0–1	0.5, 0.3	Children; Adults, respectively	EPA, 1989a
– Inhalation:	0–1	1	Complete absorption assumed	EPA, 1989a
Permeability Constant – Dermal contact in Water (cm/hr)		8.4E–04	Based upon the penetration rate of water	EPA 1989
Chemical Concentration Justification			Geometric mean and maximum values used in exposure estimates were calculated using the methods described in text.	
Surface Soils; Subsurface soils, Ground Water				

TABLE 5-7
(continued)
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE – TANK FARM FOUR

Scenario 1 – Current Use: Trespassing					
Exposure Frequency (days/year)	1–365	350	Daily entry on site with 2 weeks away from area		
Ingestion Of Chemicals In Soils					EPA 1989a
Ingestion Rate (mg/day) (children)	0–200	100	Soil ingestion rate for those under 6 years of age.		
Ingestion Rate (mg/day) (adults)	0–480	100	Typical soil ingestion rate for adults		
Contact With Surface Water					
Exposure Frequency (days/year)	1–365	150	Daily surface water contact during warm months only		
Surface Area (children)	0–13130	7505	Feet, legs, arms, and hands getting wet		
Surface Area (adults)	0–18150	5673	Feet, lower legs, forearms, and hands getting wet.		
Scenario 2 – Future Use: Construction					
Exposure Frequency (days/year)	1–365	250	Based upon one year to construct an industrial facility.		
Ingestion Of Chemicals In Soils					EPA 1991
Ingestion Rate (mg/day)	0–480	480	Soil ingestion rate for construction work		
Inhalation Of Airborne Chemicals Absorbed to Dust					EPA 1991
Inhalation Rate (m ³ /workshift)	5 0–30	20	Adults during moderate exertion		
Scenario 3 – Future Use: Industrial Exposure					
Exposure Frequency (days/year)	1–365	250	Based on an estimate of the number of workdays in one year.		EPA 1991
Ingestion Of Chemicals In Drinking Water					EPA 1991
Ingestion Rate (L/day)	0–2	1	Water ingestion rate for a commercial setting		
Ingestion Of Chemicals In Soils					EPA 1991
Ingestion Rate (mg/day)	0–480	50	Soil ingestion rate for a commercial setting.		
Scenario 4 – Future Use: Residential Scenario					
Exposure Frequency (days/yr)	1–365	350	Two weeks spent away from home.		EPA 1991
Ingestion Of Chemicals In Soils and House Dust					
Ingestion Rate (mg/day)					
Child	0–200	200	Children, 1–6 years old		EPA 1991
Adult	0–480	100	Typical ingestion rate for adults		EPA 1991
Ingestion Of Chemicals In Drinking Water					
Ingestion Rate (L/day)					
Child		0.750	Children, 0–6 years old		EPA 1990
Adult		2	Adult, 90th percentile		EPA 1989
Inhalation Of Airborne (Vapor Phase) Chemicals					
Inhalation Rate (m ³ /hr)	0 7–6	0 625	Adults and children, light activity assumed.		EPA 1990
Exposure Time (hrs/day)	0.1–0 2	0 2 hr	Based upon the duration of a shower.		EPA 1990
Inhalation Of Airborne Chemicals Absorbed to Dust					
Inhalation Rate (m ³ /hr)	0 7–6	0 83	Adults and children, light activity assumed.		EPA 1990
Exposure Time (hr/day)	1–24	24	Outdoor and indoor dust exposure		EPA 1990

TABLE 5-8
SCENARIO 1
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FOUR

	TOTAL PATHWAY RISK	TOTAL RISK	
	1.2E-06	1.8E-05	CHILD MEAN
	1.8E-06	2.8E-05	ADULT MEAN
	6.2E-07	5.4E-05	CHILD MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	9.2E-07	8.2E-05	ADULT MAXIMUM
	1.7E-05		CHILD MEAN
	2.6E-05		ADULT MEAN
	5.3E-05		CHILD MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	8.1E-05		ADULT MAXIMUM
	3.6E-08		CHILD MEAN
	4.2E-08		ADULT MEAN
	4.0E-08		CHILD MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER	4.7E-08		ADULT MAXIMUM
	2.3E-07		CHILD MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SURFACE WATER	3.2E-07		CHILD MAXIMUM

TABLE 5-9
SCENARIO 1
SUMMARY OF CHRONIC HAZARD INDEX RATIOS
TANK FARM FOUR

	PATHWAY	TOTAL
	HAZARD	HAZARD
	INDEX	INDEX
	3.7E-03	1.0E-01 CHILD MEAN
	2.3E-03	5.5E-02 ADULT MEAN
	2.0E-03	1.4E-01 CHILD MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.3E-03	6.9E-02 ADULT MAXIMUM
	8.4E-02	CHILD MEAN
	5.2E-02	ADULT MEAN
	1.1E-01	CHILD MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	6.7E-02	ADULT MAXIMUM
	2.2E-03	CHILD MEAN
	1.0E-03	ADULT MEAN
	2.6E-03	CHILD MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN WATER	1.2E-03	ADULT MAXIMUM
	1.4E-02	CHILD MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SURFACE WATER	2.5E-02	CHILD MAXIMUM

TABLE 5-10
SCENARIO 2
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FOUR

	TOTAL PATHWAY RISK	TOTAL RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.1E-08 1.8E-08	2.9E-06 4.7E-06	MEAN MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.9E-06 4.7E-06	MEAN MAXIMUM	
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	1.0E-08 1.9E-08	MEAN MAXIMUM	

TABLE 5-11
SCENARIO 2
SUMMARY OF CHRONIC HAZARD INDEX RATIOS
TANK FARM FOUR

	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)	
	2.3E-04	1.9E-01	MEAN
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	3.2E-04	2.7E-01	MAXIMUM
	1.9E-01		MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	2.6E-01		MAXIMUM
	3.6E-03		MEAN
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	4.7E-03		MAXIMUM

TABLE 5-12
SCENARIO 3
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FOUR

	TOTAL PATHWAY RISK	TOTAL RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.1E-06 5.7E-07	1.3E-04 2.9E-03	MEAN MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	7.6E-06 2.4E-05	MEAN MAXIMUM	
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER	1.2E-04 2.9E-03	MEAN MAXIMUM	

TABLE 5-13
SCENARIO 3
SUMMARY OF CHRONIC HAZRD INDEXRATIOS
TANK FARM FOUR

CHEMICAL	CHRONIC DAILY INTAKE (CDI) - MEAN (mg/kg/day)	CHRONIC DAILY INTAKE (CDI) - MAX (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENCE LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD UNCERTAINTY ADJUSTMENTS	MODIFYING FACTORS	HAZARD QUOTIENT MEAN	HAZARD QUOTIENT MAXIMUM	PATHWAY HAZARD INDEX (HI)	TOTAL HAZARD INDEX (HI)
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL												1.8E-03	1.9E+00 MEAN
												2.0E-03	1.3E+01 MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL												1.0E-02	MEAN
												2.5E-02	MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER												1.0E+00	MEAN
												1.3E+01	MAXIMUM
INORGANICS													
Arsenic	1.4E-04	4.4E-03	No	1E-03		Keratosis and hyperpigmentation	NA/HEAST	UF=1		1.4E-01	4.4E+00		
Chromium	1.6E-04	3.6E-03	No	5E-03	Low	None Observed	Water/RIS, HEAST	UF=500	MF=1	3.2E-02	7.7E-01		
Manganese	2.2E-02	1.1E-01	No	1E-01	Medium	CNS effects	Diet/RIS, HEAST	UF=1	MF=1	2.2E-01	1.1E+00		
Thallium	9.6E-05	3.9E-04	No	7E-05		Increased SGOT and serum LDH levels, alopecia	Diet/HEAST	UF=3000		1.4E+00	5.6E+00		

TABLE 5-14
SCENARIO 4
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FOUR

CHEMICAL	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX (mg/kg/day)	CDI ADULT MAX (mg/kg/day)	ADJ FOR ABSORPTION	SF	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEMICAL RISK CHILD MEAN	CHEMICAL RISK ADULT MEAN	CHEMICAL RISK CHILD MAXIMUM	CHEMICAL RISK ADULT MAXIMUM	TOTAL PATHWAY RISK	TOTAL RISK
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER															1 5E-04 2 0E-04 CHILD MEAN 4 0E-04 4 3E-04 ADULT MEAN 3 6E-03 3 7E-03 CHILD MAX 0 7E-03 0 6E-03 ADULT MAX
INORGANICS															
Arsenic	8 0E-05	1 6E-04	1 9E-03	5 3E-03	No	1 75E+00	A	Skin	IRIS	1 0E-04	2 9E-04	3 4E-03	9 2E-03		
Beryllium	4 9E-06	1 3E-05	3 6E-05	1 0E-04	No	4 30E+00	B2	Gross tumors all sites combined	Water/IRIS	2 1E-05	5 7E-05	1 6E-04	4 3E-04		
SEMIVOLATILES															
2,3-Dichlorobenzidine	4 9E-05	1 3E-04	8 6E-05	2 3E-04	No	4 50E-01	B2	Mammary adenocarcinomas	Water/IRIS	2 2E-05	6 1E-05	3 9E-05	1 1E-04		
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL															1 8E-06 CHILD MEAN 1 8E-06 ADULT MEAN 9 2E-07 CHILD MAXIMUM 9 0E-07 ADULT MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST															5 0E-05 CHILD MEAN 2 6E-05 ADULT MEAN 1 0E-04 CHILD MAXIMUM 6 1E-05 ADULT MAXIMUM
SEMIVOLATILES															
Chrysene	5 0E-07	2 6E-07	1 1E-05	5 6E-06	No	1 15E+01	B2	Malignant lymphoma	IRIS	5 7E-08	3 0E-08	1 3E-04	6 5E-05		
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS															0 0E+00 CHILD MEAN 0 0E+00 ADULT MEAN 0 0E+00 CHILD MAXIMUM 0 0E+00 ADULT MAXIMUM
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST															2 3E-06 CHILD MEAN 2 4E-08 ADULT MEAN 4 8E-08 CHILD MAXIMUM 5 0E-06 ADULT MAXIMUM

TABLE 5-15
SCENARIO 4
SUMMARY OF CHRONIC HAZARD INDEX RATIO ESTIMATES
TANK FARM FOUR

CHEMICAL	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX. (mg/kg/day)	CDI ADULT MAX. (mg/kg/day)	CDI ADJ. FOR ABSORPTION	RFD (mg/kg/day)	CONFIDENC LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	RFD [UNCRTNTY ADJSTMNT	MF	HI CHILD MEAN	HI ADULT MEAN	HI CHILD MAX	HI ADULT MAX	PATHWAY HAZARD INDEX	TOTAL HAZARD INDEX	
9.7E+00																	1.0E+01	CHILD MEAN
5.3E+00																	6.4E+00	ADULT MEAN
6.6E+01																	6.6E+01	CHILD MAXIMUM
3.6E+01																	3.6E+01	ADULT MAXIMUM
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN DRINKING WATER																		
INORGANICS																		
Arsenic	7.0E-04	3.8E-04	2.2E-02	1.2E-02	No	1E-03	Low	Keratosis and hyperpigmentation	NA/HEAST	UF=1		7.0E-01	3.8E-01	2.2E+01	1.2E+01			
Chromium	8.3E-04	4.5E-04	2.0E-02	1.1E-02	No	5E-03		None Observed	Water/IRIS, HEAST	UF=500	MF=1	1.7E-01	9.1E-02	3.9E+00	2.1E+00			
Manganese	1.1E-01	6.3E-02	6.7E-01	3.2E-01	No	1E-01	Medium	CNS effects	Diet/IRIS, HEAST	UF=1	MF=1	1.1E+00	6.3E-01	6.7E+00	3.2E+00			
Thallium	5.0E-04	2.8E-04	2.0E-03	1.1E-03	No	7E-05		Increased SGOT and serum LDH levels, alopecia	Diet/HEAST	UF=3000		7.2E+00	3.9E+00	2.9E+01	1.6E+01			
Vanadium	6.6E-04	3.6E-04	8.4E-03	4.6E-03	No	7E-03		None Observed	Water/HEAST	UF=100		9.4E-02	5.2E-02	1.2E+00	6.6E-01			
1.2E-02																	CHILD MEAN	
2.6E-03																	ADULT MEAN	
1.3E-02																	CHILD MAXIMUM	
2.8E-03																	ADULT MAXIMUM	
EXPOSURE PATHWAY DERMAL CONTACT WITH CHEMICALS IN SOIL																		
6.1E-01																	CHILD MEAN	
6.3E-02																	ADULT MEAN	
6.9E-01																	CHILD MAXIMUM	
7.2E-02																	ADULT MAXIMUM	
EXPOSURE PATHWAY INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																		
NA																	CHILD MEAN	
NA																	ADULT MEAN	
NA																	CHILD MAXIMUM	
NA																	ADULT MAXIMUM	
EXPOSURE PATHWAY INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																		
1.6E-03																	CHILD MEAN	
3.2E-04																	ADULT MEAN	
2.6E-03																	CHILD MAXIMUM	
5.2E-04																	ADULT MAXIMUM	
EXPOSURE PATHWAY INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																		

TABLE 5-16
SUMMARY OF EXPOSURE PATHWAYS
TANK FARM FOUR

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Inclusion
Current Land Use			
Children	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Children	Ingestion of soils on site	Yes	Access to site possible
Children	Ingestion of sediments on site	No	Soils data includes contamination near shore
Children	Ingestion of surface water on site	Yes	Access to stream possible
Children	Dermal contact with soils	Yes	Access to site possible
Children	Dermal contact with sediments	No	Soils data includes contamination near shore
Children	Inhalation of fugitive dusts	No	Site vegetated
Children	Dermal contact with surface water	Yes	Access to stream possible
Future Land Use			
Residents	Ingestion of ground water from local wells on the site	Yes	Potential residential use of site
Residents	Ingestion of soils on site	Yes	Potential residential use of site
Residents	Ingestion of sediments on site	No	Soils data includes contamination near shore
Residents	Ingestion of surface water on site	No	Pathway modeled in current use and is of minor importance compared to groundwater ingestion.
Residents	Dermal contact with soils	Yes	Potential residential use of site
Residents	Dermal contact with sediments	No	Soils data includes contamination near shore
Residents	Inhalation of fugitive dusts	Yes	Potential residential use of site may produce areas devoid of cover
Residents	Inhalation of chemicals volatilized from ground water during home use	Yes	Potential residential use of site; volatile organics in ground water
Construction Workers	Ingestion of ground water from local wells	No	Wells not developed during construction
Construction Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Construction Workers	Ingestion of sediments on site	No	Soils data includes contamination near shore
Construction Workers	Ingestion of surface water on site	No	Contact route unlikely
Construction Workers	Dermal contact with soils	Yes	Contact with soils expected during construction
Construction Workers	Dermal contact with sediments	No	Contact route unlikely
Construction Workers	Inhalation of fugitive dusts	Yes	Generation of fugitive dust expected during construction
Industrial Employees	Ingestion of ground water from local wells	Yes	Potable supply from ground water
Industrial Employees	Ingestion of soils on site	Yes	Incidental ingestion expected
Industrial Employees	Ingestion of sediments on site	No	Soils data includes contamination near shore
Industrial Employees	Ingestion of surface water on site	No	Contact route unlikely
Industrial Employees	Dermal contact with soils	Yes	Contact with soils may occur during work hours
Industrial Employees	Dermal contact with sediments	No	Contact route unlikely
Industrial Employees	Inhalation of fugitive dusts	No	Generation of fugitive dust not expected (Site vegetated or paved)

TABLE 6-1
SUMMARY OF SURFACE SOIL DATA
FROM TANK FARM FIVE

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
INORGANICS							
Aluminum	4/4	0.2 ^a	2730-9550	5264	9550	33000	7000-100000
Antimony	2/4	3.7-3.85	5.3-5.4	3.18	5.4	0.52	<1-8.8
Arsenic	2/4	1.1-1.25	6.6-10.1	2.19	10.1	4.8	0.1-73
Barium	4/4	0.2 ^a	8.8-19.9	13.19	19.9	290	10-1500
Beryllium	2/4	0.23-0.24	0.175-0.27	0.16	0.27	0.55	1-7
Cadmium	0/4	0.5-0.73	NA	NA	NA	0.28 ^c	NA
Calcium	4/4	5.0 ^a	322-854	583	854	3400	100-280000
Chromium	4/4	0.01 ^a	2.45-14	5.98	14	33	1-1000
Cobalt	4/4	0.05 ^a	2.4-15.1	5.84	15.1	5.9	0.3-70
Copper	2/4	4.2-4.6	24.3-19.8	8.97	24.3	13	1-700
Cyanide	0/2	0.535-0.54	NA	NA	NA	NA	NA
Iron	4/4	0.1 ^a	4480-25500	10609	25500	14000	100-100000
Lead	4/4	0.005 ^a	5.1-56.6	19.34	56.6	14	10-300
Magnesium	4/4	5.0 ^a	772-2680	1470	2960	2100	50-50000
Manganese	4/4	0.015 ^a	122-445	227	445	260	2-7000
Mercury	2/4	0.11	2.0-54.0	0.78	54	0.081	0.01-3.4
Nickel	2/4	3.85-4.0	19.5-21.0	8.30	21	11	5-700
Potassium	4/4	5.0 ^a	182-255	221	255	12000	50-37000
Selenium	2/4	0.45	0.38	0.29	0.39	0.3	0.1-3.9
Silver	1/4	0.5-0.73	0.7	0.43	0.7	NA	NA
Sodium	0/4	20.7-78.4	NA	NA	NA	7.7	500-50000
Thallium	2/4	0.73-0.78	0.9	0.58	0.9	2.2	2.2-23
Vanadium	2/4	5.3-5.7	20.3-21.0	7.53	21	43	7-300
Zinc	4/4	0.02 ^a	55.5-83	64.44	83	40	5-2900
VOLATILES							
1,1-Dichloroethane	0/4	0.006	NA	NA	NA	NA	NA
1,1-Dichloroethene	0/4	0.006	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	1/4	0.006	0.006	0.0036	0.006	NA	NA
1,1,2-Trichloroethane	1/4	0.006	0.006	0.0036	0.006	NA	NA
1,1,2,2-Tetrachloroethane	1/4	0.006	0.006	0.0036	0.006	NA	NA
1,2-Dichloroethane	0/4	0.006	NA	NA	NA	NA	NA
1,2-Dichloroethene	0/4	0.006	NA	NA	NA	NA	NA
1,2-Dichloropropane	1/4	0.006	0.006	0.0036	0.006	NA	NA
1,3-Dichloropropane (Cis)	1/4	0.006	0.006	0.0036	0.006	NA	NA
1,3-Dichloropropane (Trans)	1/4	0.006	0.006	0.0036	0.006	NA	NA
2-Butanone	0/4	0.010 ^a	NA	NA	NA	NA	NA
2-Hexanone	1/4	0.012-0.013	0.012	0.0073	0.012	NA	NA
4-Methyl-2-Pentanone	1/4	0.012-0.013	0.012	0.0073	0.012	NA	NA
Acetone	0/4	0.01-0.027	NA	NA	NA	NA	NA
Benzene	1/4	0.006	0.006	0.0036	0.006	NA	NA
Bromodichloromethane	1/4	0.006	0.006	0.0036	0.006	NA	NA
Bromoforn	1/4	0.006	0.006	0.0036	0.006	NA	NA
Bromomethane	0/4	0.012-0.013	NA	NA	NA	NA	NA
Carbon disulfide	2/4	0.006	0.006	0.0042	0.006	NA	NA
Carbon Tetrachloride	1/4	0.006	0.006	0.0042	0.006	NA	NA
Chlorobenzene	1/4	0.006	0.006	0.0036	0.006	NA	NA
Chloroethane	0/4	0.012-0.013	NA	NA	NA	NA	NA
Chloroform	0/4	0.006	NA	NA	NA	NA	NA
Chloromethane	0/4	0.012-0.013	NA	NA	NA	NA	NA
Dibromochloromethane	1/4	0.006	0.006	0.0036	0.006	NA	NA
Ethylbenzene	1/4	0.006	0.006	0.0036	0.006	NA	NA
Methylene chloride	0/4	0.008-0.017	NA	NA	NA	NA	NA
Styrene	1/4	0.006	0.006	0.0036	0.006	NA	NA
Tetrachloroethene	4/4	0.005 ^a	0.002-0.006	0.0039	0.006	NA	NA
Toluene	2/4	0.006	0.002-0.006	0.0032	0.006	NA	NA
Trichloroethene	1/4	0.006	0.006	0.0036	0.006	NA	NA
Vinyl acetate	2/4	0.012-0.013	0.012	0.0087	0.012	NA	NA
Vinyl chloride	0/4	0.012-0.013	NA	NA	NA	NA	NA
Xylenes	2/4	0.006	0.002-0.006	0.0032	0.006	NA	NA

a : SQLs in parenthesis are the contract required quantitation limits (CQL)
b : U.S. background range and average concentration are from (USGS, 1984)
NA : Not Applicable

TABLE 6-1 (cont.)
SUMMARY OF SURFACE SOIL DATA
FROM TANK FARM FIVE

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
SEMIVOLATILES							
1,2-Dichlorobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
1,2,4-Trichlorobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
1,3-Dichlorobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
1,4-Dichlorobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
2-Chloronaphthalene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
2-Chlorophenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2-Methylnaphthalene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
2-Methylphenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2-Nitroaniline	2/4	2.2-2.3	2.0-2.1	1.51	2.1	NA	NA
2-Nitrophenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2,4-Dichlorophenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2,4-Dimethylphenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2,4-Dinitrophenol	1/4	2.2-2.3	2.0	1.29	2	NA	NA
2,4-Dinitrotoluene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
2,4,6-Trichlorophenol	1/4	2.2-2.3	2.0	1.29	2	NA	NA
2,4,6-Trichlorophenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
2,6-Dinitrotoluene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
3-Nitroaniline	2/4	2.2-2.3	2.0-2.05	1.51	2.05	NA	NA
3,3'-Dichlorobenzidine	2/4	0.89-0.93	0.81	0.61	0.81	NA	NA
4-Bromophenyl-phenylether	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
4-Chloro-3-methylphenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
4-Chloroaniline	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
4-Chlorophenyl-phenylether	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
4-Methylphenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
4-Nitroaniline	2/4	2.2-2.3	2.0-2.05	1.51	2.05	NA	NA
4-Nitrophenol	1/4	2.2-2.3	2.0	1.29	2	NA	NA
4,6-dinitro-2-methylphenol	1/4	2.2-2.3	2.0	1.29	2	NA	NA
Acenaphthene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Acenaphthylene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Anthracene	3/4	0.47	0.045-0.41	0.21	0.41	NA	NA
Benzoic acid	2/4	2.2-2.3	2.0-2.2	1.54	2.2	NA	NA
Benzo(a)anthracene	4/4	0.33 ^a	0.084-0.41	0.22	0.41	NA	NA
Benzo(a)pyrene	4/4	0.33 ^a	0.089-0.41	0.20	0.41	NA	NA
Benzo(b)fluoranthene	3/4	0.47	0.14-0.41	0.27	0.41	NA	NA
Benzo(g,h,i)perylene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Benzo(k)fluoranthene	3/4	0.44	0.07-0.41	0.23	0.41	NA	NA
Benzyl Alcohol	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Bis(2-chloroethoxy)methane	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Bis(2-chloroethyl)ether	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Bis(2-chloroisopropyl)ether	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Bis(2-ethylhexyl)phthalate	2/4	0.48-0.56	0.071-0.41	0.21	0.41	NA	NA
Butylbenzylphthalate	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Chrysene	4/4	0.33 ^a	0.05-0.41	0.24	0.41	NA	NA
Dibenzofuran	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Dibenzo(a,h)anthracene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Diethylphthalate	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Dimethylphthalate	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Di-n-butylphthalate	4/4	0.33 ^a	0.046-0.41	0.14	0.41	NA	NA
Di-n-octylphthalate	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Fluoranthene	4/4	0.33 ^a	0.18-0.41	0.33	0.41	NA	NA
Fluorene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Hexachlorobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Hexachlorobutadiene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Hexachlorocyclopentadiene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Hexachloroethane	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Indeno(1,2,3-cd)pyrene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Isophorone	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Naphthalene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Nitrobenzene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
N-nitroso-di-n-propylamine	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
N-nitrosodiphenylamine	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
Pentachlorophenol	1/4	2.2-2.3	2.0	1.29	2	NA	NA
Phenanthrene	4/4	0.33 ^a	0.072-0.41	0.23	0.41	NA	NA
Phenol	1/4	0.44-0.47	0.41	0.26	0.41	NA	NA
Pyrene	2/4	0.44-0.47	0.41	0.31	0.41	NA	NA
PESTICIDES							
4,4'-DDD	0/2	0.041-0.043	NA	NA	NA	NA	NA
4,4'-DDE	2/2	0.016 ^a	0.025-0.032	0.01	0.032	NA	NA
4,4'-DDT	2/2	0.016 ^a	0.031-0.074	0.02	0.074	NA	NA
Aldrin	0/2	0.021	NA	NA	NA	NA	NA
Alpha-BHC	0/2	0.021	NA	NA	NA	NA	NA
Alpha-chlorodane	0/2	0.21	NA	NA	NA	NA	NA
Beta-BHC	0/2	0.021	NA	NA	NA	NA	NA
Deslin	0/2	0.041-0.043	NA	NA	NA	NA	NA
Delta-BHC	0/2	0.021	NA	NA	NA	NA	NA
Endosulfan I	0/2	0.021	NA	NA	NA	NA	NA
Endosulfan II	0/2	0.041-0.043	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/2	0.041-0.043	NA	NA	NA	NA	NA
Endrin	0/2	0.041-0.043	NA	NA	NA	NA	NA
Endrin ketone	0/2	0.041-0.043	NA	NA	NA	NA	NA
Gamma-BHC	0/2	0.021	NA	NA	NA	NA	NA
Gamma-chlorodane	0/2	0.21	NA	NA	NA	NA	NA
Heptachlor	0/2	0.021	NA	NA	NA	NA	NA
Heptachlor epoxide	0/2	0.021	NA	NA	NA	NA	NA
Methoxychlor	0/2	0.21	NA	NA	NA	NA	NA
Toxaphene	0/2	0.43	NA	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/4	0.125-0.21	NA	NA	NA	NA	NA
Aroclor-1221	0/4	0.125-0.21	NA	NA	NA	NA	NA
Aroclor-1232	0/4	0.125-0.21	NA	NA	NA	NA	NA
Aroclor-1242	0/4	0.125-0.21	NA	NA	NA	NA	NA
Aroclor-1246	0/4	0.125-0.21	NA	NA	NA	NA	NA
Aroclor-1254	0/4	0.245-0.43	NA	NA	NA	NA	NA
Aroclor-1260	0/4	0.245-0.43	NA	NA	NA	NA	NA

a : SQLs in parenthesis are the contract required quantitation limits (CQL)
b : U.S. background range and average concentration are from (USGS, 1984)
NA : Not Applicable

TABLE 6-2
SUMMARY OF SUBSURFACE SOIL DATA
FROM TANK FARM 5

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
INORGANICS							
Aluminum	8/8	0.2 ^a	4750-15000	7928.55	15000	33000	7000-100000
Antimony	2/6	5.4	7.7-10.1	5.94	10.1	0.52	<1-8.8
Arsenic	6/6	0.01 ^a	7-31.3	15.36	31.1	4.8	0.1-73
Barium	6/6	0.2 ^a	6.6-15.1	9.36	15.1	290	10-1500
Beryllium	3/6	0.19-0.24	0.31-0.66	0.20	0.56	0.55	1-7
Cadmium	0/6	0.52-0.75	NA	NA	NA	0.26 ^c	NA
Calcium	6/6	5 ^a	642-2660	1242.33	2660	3400	100-280000
Chromium	6/6	0.01 ^a	7.1-16.5	11.77	16.5	33	1-1000
Cobalt	6/6	0.05 ^a	7.7-42.5	20.52	42.5	5.9	0.3-70
Copper	6/6	0.025 ^a	12.8-41	24.73	41	13	1-700
Cyanide	0/6	0.53-0.64	NA	NA	NA	NA	NA
Iron	6/6	0.1 ^a	16000-50700	29090.75	50700	14000	100-100000
Lead	6/6	0.005 ^a	2.7-13.9	6.92	13.9	14	10-300
Magnesium	0/6	5 ^a	1300-5010	2511.11	5010	2100	50-50000
Manganese	6/6	0.015 ^a	224-715	429.35	715	260	2-7000
Mercury	0/6	0.11	NA	NA	NA	0.081	0.01-3.4
Nickel	6/6	0.04 ^a	16.1-43.6	24.48	43.6	11	5-700
Potassium	1/6	129-178	201	85.51	201	12000	50-37000
Selenium	1/6	0.31-0.5	0.41	0.22	0.41	0.3	0.1-3.9
Silver	4/6	0.52-0.74	0.77-1.7	0.69	1.7	NA	NA
Sodium	1/6	15.8-22.4	18.9	10.24	18.9	2500	500-50000
Thallium	0/6	0.63-1.0	NA	NA	NA	7.7	2.2-23
Vanadium	3/6	0.05 ^a	11-40.6	18.85	40.6	43	7-300
Zinc	6/6	0.02 ^a	37.4-93.3	54.57	93.3	40	5-2900
VOLATILES							
1,1-Dichloroethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,1-Dichloroethene	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,2-Dichloroethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,2-Dichloroethene	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,2-Dichloropropane	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,3-Dichloropropene (Cis)	0/6	0.005-0.007	NA	NA	NA	NA	NA
1,3-Dichloropropene (Trans)	0/6	0.005-0.007	NA	NA	NA	NA	NA
2-Butanone	0/6	NA	NA	NA	NA	NA	NA
2-Hexanone	0/6	0.01-0.013	NA	NA	NA	NA	NA
4-Methyl-2-Pentanone	0/6	0.01-0.013	NA	NA	NA	NA	NA
Acetone	0/6	0.002-0.061	NA	NA	NA	NA	NA
Benzene	0/6	0.005-0.007	NA	NA	NA	NA	NA
Bromodichloromethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
Bromoforn	0/6	0.005-0.007	NA	NA	NA	NA	NA
Bromomethane	0/6	0.01-0.013	NA	NA	NA	NA	NA
Carbon disulfide	0/6	0.005-0.007	NA	NA	NA	NA	NA
Carbon Tetrachloride	1/6	0.005-0.006	0.007	0.003	0.007	NA	NA
Chlorobenzene	0/6	0.005-0.007	NA	NA	NA	NA	NA
Chloroethane	0/6	0.01-0.013	NA	NA	NA	NA	NA
Chloroform	0/6	0.005-0.007	NA	NA	NA	NA	NA
Chloromethane	0/6	0.01-0.013	NA	NA	NA	NA	NA
Dibromochloromethane	0/6	0.005-0.007	NA	NA	NA	NA	NA
Ethylbenzene	0/6	0.005-0.007	NA	NA	NA	NA	NA
Methylene chloride	0/6	0.004-0.02	NA	NA	NA	NA	NA
Styrene	0/6	0.005-0.007	NA	NA	NA	NA	NA
Tetrachloroethene	1/6	0.005-0.007	0.001	0.002	0.001	NA	NA
Toluene	1/6	0.005-0.007	0.003	0.003	0.003	NA	NA
Trichloroethene	0/6	0.005-0.007	NA	NA	NA	NA	NA
Vinyl acetate	0/6	0.01-0.013	NA	NA	NA	NA	NA
Vinyl chloride	0/6	0.01-0.013	NA	NA	NA	NA	NA
Xylenes	0/6	0.005-0.007	NA	NA	NA	NA	NA

a : SQLs in parenthesis are the contract required quantitation limits (CRQL)
b : U.S. background range and average concentration are from (USGS, 1984)
c : Average U.S. background (Carey, 1979)
NA : Not Applicable

TABLE 6-2 (cont.)
SUMMARY OF SUBSURFACE SOIL DATA
FROM TANK FARM 5

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SOL (mg/kg)	RANGE OF DETECTION (mg/kg)	GEOMETRIC MEAN CONCENTRATION (mg/kg)	ON SITE MAXIMUM CONCENTRATION (mg/kg)	GEOMETRIC MEAN OF U.S. BACKGROUND (mg/kg) ^b	RANGE OF U.S. BACKGROUND (mg/kg) ^b
SEMIVOLATILES							
1,2-Dichlorobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
1,2,4-Trichlorobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
1,3-Dichlorobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
1,4-Dichlorobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2-Chloronaphthalene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2-Chlorophenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2-Methylnaphthalene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2-Methylphenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2-Nitroaniline	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
2-Nitrophenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2,4-Dichlorophenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2,4-Dimethylphenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
2,4-Dinitrophenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2,4,5-Trichlorophenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
2,4,6-Trichlorophenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
2,6-Dinitrotoluene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
3-Nitroaniline	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
3,3'-Dichlorobenzidine	2/8	0.75-0.81	0.75-0.87	0.499	0.87	NA	NA
4-Bromophenyl-phenylether	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
4-Chloro-3-methylphenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
4-Chloroaniline	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
4-Chlorophenyl-phenylether	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
4-Methylphenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
4-Nitroaniline	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
4-Nitrophenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
4,6-dinitro-2-methylphenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
Acenaphthene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Acenaphthylene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Anthracene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Benzoic acid	3/8	1.9-2.0	0.095-2.2	0.850	2.2	NA	NA
Benzo(a)anthracene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Benzo(e)pyrene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Benzo(b)fluoranthene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Benzo(ghi)perylene	5/8	0.38	0.37-0.43	0.353	0.43	NA	NA
Benzo(k)fluoranthene	2/8	0.38-0.41	0.37-0.43	0.314	0.43	NA	NA
Benzyl Alcohol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Bis(2-chloroethoxy)methane	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Bis(2-chloroethyl)ether	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Bis(2-chloroisopropyl)ether	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Bis(2ethylhexyl)phthalate	1/8	0.044-0.38	0.43	0.065	0.43	NA	NA
Butylbenzylphthalate	2/8	0.38-0.41	0.43-2.0	0.331	2	NA	NA
Chrysene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Dibenzofuran	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Dibenzo(a,h)anthracene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Diethylphthalate	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Dimethylphthalate	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Di-n-butylphthalate	2/8	0.38-0.41	0.12-2.6	0.279	2.6	NA	NA
Di-n-octylphthalate	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Fluoranthene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Fluorene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Hexachlorobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Hexachlorobutadiene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Hexachlorocyclopentadiene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Hexachloroethane	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Indeno(1,2,3-cd)pyrene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Isophorone	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Naphthalene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Nitrobenzene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
N-nitroso-d-n-propylamine	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
N-nitrosodiphenylamine	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Pentachlorophenol	2/8	1.9-2.0	1.9-2.2	1.258	2.2	NA	NA
Phenanthrene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Phenol	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
Pyrene	2/8	0.38-0.41	0.37-0.43	0.250	0.43	NA	NA
PESTICIDES							
4,4'-DDD	0/6	0.016-0.021	NA	NA	NA	NA	NA
4,4'-DDE	1/6	0.016-0.021	0.0036	0.008	0.0036	NA	NA
4,4'-DDT	1/6	0.016-0.021	0.017	0.010	0.017	NA	NA
Aldrin	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Alpha-BHC	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Alpha-chlordane	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Beta-BHC	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Delalin	0/6	0.016-0.021	NA	NA	NA	NA	NA
Delta-BHC	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Endosulfan I	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Endosulfan II	0/6	0.016-0.021	NA	NA	NA	NA	NA
Endosulfan Sulfate	0/6	0.016-0.021	NA	NA	NA	NA	NA
Endrin	0/6	0.016-0.021	NA	NA	NA	NA	NA
Endrin ketone	0/6	0.016-0.021	NA	NA	NA	NA	NA
Gamma-BHC	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Gamma-chlordane	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Heptachlor	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Heptachlor epoxide	0/6	0.0081-0.01	NA	NA	NA	NA	NA
Methoxychlor	0/6	0.081-0.1	NA	NA	NA	NA	NA
Toxaphene	0/6	0.16-0.21	NA	NA	NA	NA	NA
PCB's							
Aroclor-1016	0/6	0.081-0.1	NA	NA	NA	NA	NA
Aroclor-1221	0/6	0.081-0.1	NA	NA	NA	NA	NA
Aroclor-1232	0/6	0.081-0.1	NA	NA	NA	NA	NA
Aroclor-1242	0/6	0.081-0.1	NA	NA	NA	NA	NA
Aroclor-1248	0/6	0.081-0.1	NA	NA	NA	NA	NA
Aroclor-1254	0/6	0.023-0.23	NA	NA	NA	NA	NA
Aroclor-1260	0/6	0.16-0.21	NA	NA	NA	NA	NA

a : SOLs in parenthesis are the contract required quantitation limits (CQL)
b : U.S. background range and average concentration are from (USGS, 1984)
c : Average U.S. background (Carey, 1979)
NA : Not Applicable

TABLE 6-3
SUMMARY OF MONITORING WELL DATA
FROM TANK FARM 5

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN OF CONCENTRATION (µg/L)	ON SITE MAXIMUM CONCENTRATION (µg/L)	BACKGROUND LEVEL MW-6 (µg/L)
INORGANICS						
Aluminum	8/8	(200)a	3900-190000	53485.0	190000	88000
Antimony	0/8	22	NA	NA	NA	<22
Arsenic	8/8	(10)a	21.4-265	72.9	265	31.6
Barium	8/8	(200)a	24-489	169.1	489	345
Beryllium	6/8	1.0	2.4-10.2	3.4	10.2	5.5
Cadmium	1/8	3	5.0	1.7	5	<3.0
Calcium	8/8	(5000)a	23000-89700	54395.6	89700	44900
Chromium	8/8	(10)a	2.4-384	88.0	384	116
Cobalt	8/8	(50)a	22.8-295	125.9	295	210
Copper	7/8	14.4	52.4-304	99.8	304	297
Cyanide	0/8	10	NA	NA	NA	5
Iron	8/8	(100)a	34700-787100	252564.3	787100	288000
Lead	8/8	(5)a	13.4-630	93.4	630	108
Magnesium	8/8	(5000)a	11700-108000	48435.1	108000	51300
Manganese	8/8	(15)a	1240-10200	5388.7	10200	7650
Mercury	0/8	0.2	NA	NA	NA	<0.2
Nickel	7/8	48.0	78.9-530	217.3	530	341
Potassium	8/8	(5000)a	1790-9270	4535.6	9270	5370
Selenium	8/8	(5)a	2-20	4.9	20	2
Silver	6/8	3.0	6.3-24.5	8.9	2405	12.6
Sodium	8/8	(5000)a	7540-39600	11331.1	39600	8650
Thallium	8/8	(10)a	4.0	4.0	4	4
Vanadium	4/8	5.0-63.9	86.1-108	28.8	108	<63.9
Zinc	8/8	(20)a	69.8-1630	628.7	1630	708
VOLATILES						
1,1-Dichloroethane	2/9	5	4-23	3.37	23	<5
1,1-Dichloroethene	0/9	5-25	NA	NA	NA	<5
1,1,1-Trichloroethane	2/9	5	10-190	4.72	190	<5
1,1,2-Trichloroethane	0/9	5-25	NA	NA	NA	<5
1,1,2,2-Tetrachloroethane	0/9	5-25	NA	NA	NA	<5
1,2-Dichloroethane	0/9	5-25	NA	NA	NA	<5
1,2-Dichloroethene	2/9	5	17-630	5.72	630	<5
1,2-Dichloropropane	0/9	5-25	NA	NA	NA	<5
1,3-Dichloropropene (Cis)	0/9	5-25	NA	NA	NA	<5
1,3-Dichloropropene (Trans)	0/9	5-25	NA	NA	NA	<5
2-Butanone	0/9	10-50	NA	NA	NA	<10
2-Hexanone	0/9	10-50	NA	NA	NA	<10
4-Methyl-2-Pentanone	0/9	10-50	NA	NA	NA	<10
Acetone	0/9	10	NA	NA	NA	<10
Benzene	0/9	5-25	NA	NA	NA	<5
Bromodichloromethane	0/9	5-25	NA	NA	NA	<5
Bromoform	0/9	5-25	NA	NA	NA	<5
Bromomethane	0/9	10-50	NA	NA	NA	<10
Carbon disulfide	0/9	5-25	NA	NA	NA	<5
Carbon Tetrachloride	0/9	5-25	NA	NA	NA	<5
Chlorobenzene	0/9	5-25	NA	NA	NA	<5
Chloroethane	0/9	10-50	NA	NA	NA	<10
Chloroform	3/9	5-25	3-7	3.77	7	<5
Chloromethane	0/9	10-50	NA	NA	NA	<10
Dibromochloromethane	0/9	5-25	NA	NA	NA	<5
Ethylbenzene	1/9	5	47	3.46	NA	<5
Methylene chloride	0/9	6-47	NA	NA	NA	<13
Styrene	0/9	5-25	NA	NA	NA	<5
Tetrachloroethene	1/9	5	7	2.80	7	<5
Toluene	1/9	5	38	3.38	38	<5
Trichloroethene	2/9	5	4-38	3.56	38	<5
Vinyl acetate	0/9	10-50	NA	NA	NA	<10
Vinyl chloride	0/9	10-50	NA	NA	NA	<10
Xylenes	1/9	5	100	3.77	100	<5

a: SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA: Not Applicable

TABLE 8-3 (cont.)
SUMMARY OF MONITORING WELL DATA
FROM TANK FARM 5

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL	RANGE OF DETECTION (µg/L)	GEOMETRIC MEAN OF CONCENTRATION (µg/L)	ON SITE MAXIMUM CONCENTRATION (µg/L)	BACKGROUND LEVEL MW-8 (µg/L)
SEMI-VOLATILES						
1,2-Dichlorobenzene	1/9	10-100	10	6.97	10	10
1,2,4-Trichlorobenzene	1/9	10-100	10	6.97	10	10
1,3-Dichlorobenzene	1/9	10-100	10	6.97	10	10
1,4-Dichlorobenzene	1/9	10-100	10	6.97	10	10
2-Chloronaphthalene	1/9	10-100	10	6.97	10	10
2-Chlorophenol	0/9	10-100	NA	NA	NA	NA
2-Methylnaphthalene	2/9	10	10-71	7.25	71	10
2-Methylphenol	0/9	10-100	NA	NA	NA	NA
2-Nitroaniline	1/9	50-500	50	34.67	50	50
2-Nitrophenol	0/9	10-100	NA	NA	NA	NA
2,4-Dichlorophenol	0/9	10-100	NA	NA	NA	NA
2,4-Dimethylphenol	0/9	10-100	NA	NA	NA	NA
2,4-Dinitrophenol	0/9	50-500	NA	NA	NA	NA
2,4-Dinitrotoluene	1/9	10-100	10	6.97	10	10
2,4,6-Trichlorophenol	0/9	50-500	NA	NA	NA	NA
2,4,6-Trichlorophenol	0/9	10-100	NA	NA	NA	NA
2,6-Dinitrotoluene	1/9	10-100	10	6.97	10	10
3-Nitroaniline	1/9	50-500	10	34.67	10	50
3,3'-Dichlorobenzidine	1/9	20-200	20	13.95	20	20
4-Bromophenyl-phenylether	1/9	10-100	10	6.97	10	10
4-Chloro-3-methylphenol	0/9	10-100	NA	NA	NA	NA
4-Chloroaniline	1/9	10-100	10	6.97	10	10
4-Chlorophenyl-phenylether	1/9	10-100	10	6.97	10	10
4-Methylphenol	0/9	10-100	NA	NA	NA	NA
4-Nitroaniline	1/9	50-500	50	34.67	50	50
4-Nitrophenol	0/9	50-500	NA	NA	NA	NA
4,6-dinitro-2-methylphenol	0/9	50-500	NA	NA	NA	NA
Acenaphthene	1/9	10-100	10	6.97	10	10
Acenaphthylene	1/9	10-100	10	6.97	10	10
Anthracene	1/9	10-100	10	6.97	10	10
Benzoic acid	0/9	50-500	NA	NA	NA	NA
Benzo(a)anthracene	1/9	10-100	10	6.97	10	10
Benzo(a)pyrene	1/9	10-100	10	6.97	10	10
Benzo(b)fluoranthene	1/9	10-100	10	6.97	10	10
Benzo(ghi)perylene	1/9	10-100	10	6.97	10	10
Benzo(k)fluoranthene	1/9	10-100	10	6.97	10	10
Benzyl Alcohol	1/9	10-100	10	6.97	10	10
Bis(2-chloroethoxy)methane	1/9	10-100	10	6.97	10	10
Bis(2-chloroethoxy)ether	1/9	10-100	10	6.97	10	10
Bis(2-chloroisopropoxy)ether	1/9	10-100	10	6.97	10	10
Bis(2-ethoxyhexyl)phthalate	1/9	10-100	10	6.97	10	10
Butylbenzylphthalate	1/9	10-100	10	6.97	10	10
Chrysene	1/9	10-100	10	6.97	10	10
Dibenzofuran	1/9	10-100	10	6.97	10	10
Dibenzo(a,h)anthracene	1/9	10-100	10	6.97	10	10
Diethylphthalate	1/9	10-100	10	6.97	10	10
Dimethylphthalate	1/9	10-100	10	6.97	10	10
Di-n-butylphthalate	1/9	10-100	10	6.97	10	10
Di-n-octylphthalate	1/9	10-100	10	6.97	10	10
Fluoranthene	1/9	10-100	10	6.97	10	10
Fluorene	2/9	10	10-45	6.89	45	10
Hexachlorobenzene	1/9	10-100	10	6.97	10	10
Hexachlorobutadiene	1/9	10-100	10	6.97	10	10
Hexachlorocyclopentadiene	1/9	10-100	10	6.97	10	10
Hexachloroethane	1/9	10-100	10	6.97	10	10
Indeno(123cd)pyrene	1/9	10-100	10	6.97	10	10
Isophorone	1/9	10-100	10	6.97	10	10
Naphthalene	2/9	10	10-27	6.51	27	10
Nitrobenzene	1/9	10-100	10	6.97	10	10
N-nitroso-di-n-propylamine	1/9	10-100	10	6.97	10	10
N-nitrosodiphenylamine	1/9	10-100	10	6.97	10	10
Pentachlorophenol	0/9	50-500	NA	NA	NA	NA
Phenanthrene	2/9	10	10-42	6.84	42	10
Phenol	0/9	10-100	NA	NA	NA	NA
Pyrene	2/9	10	10-21	6.33	21	10
PESTICIDES						
4,4'-DDD	0/8	0.1-0.2	NA	NA	NA	<0.1
4,4'-DDE	0/8	0.1-0.2	NA	NA	NA	<0.1
4,4'-DDT	0/8	0.1-0.2	NA	NA	NA	<0.1
Aldrin	0/8	0.05-0.1	NA	NA	NA	<0.05
Alpha-BHC	0/8	0.05-0.1	NA	NA	NA	<0.05
Alpha-chlordane	0/8	0.5-1.0	NA	NA	NA	<0.5
Beta-BHC	0/8	0.05-0.1	NA	NA	NA	<0.05
Deltrin	0/8	0.1-0.2	NA	NA	NA	<0.5
Delta-BHC	0/8	0.05-0.1	NA	NA	NA	<0.05
Endosulfan I	0/8	0.05-0.1	NA	NA	NA	<0.05
Endosulfan II	0/8	0.1-0.2	NA	NA	NA	<0.1
Endosulfan Sulfate	0/8	0.1-0.2	NA	NA	NA	<0.1
Endrin	0/8	0.1-0.2	NA	NA	NA	<0.1
Endrin ketone	0/8	0.1-0.2	NA	NA	NA	<0.1
Gamma-BHC	0/8	0.05-0.1	NA	NA	NA	<0.05
Gamma-chlordane	0/8	0.5-1.0	NA	NA	NA	<0.5
Heptachlor	0/8	0.05-0.1	NA	NA	NA	<0.05
Heptachlor epoxide	0/8	0.05-0.1	NA	NA	NA	<0.05
Methoxychlor	0/8	0.5-1.0	NA	NA	NA	<0.5
Toxaphene	0/8	1.0-2.0	NA	NA	NA	<1.0
PCB's						
Aroclor-1016	0/8	0.5-1.0	NA	NA	NA	<0.5
Aroclor-1221	0/8	0.5-1.0	NA	NA	NA	<0.5
Aroclor-1232	0/8	0.5-1.0	NA	NA	NA	<0.5
Aroclor-1242	0/8	0.5-1.0	NA	NA	NA	<0.5
Aroclor-1248	0/8	0.5-1.0	NA	NA	NA	<0.5
Aroclor-1254	0/8	1.0-2.0	NA	NA	NA	<1.0
Aroclor-1260	0/8	1.0-2.0	NA	NA	NA	<1.0

a: SQLs in parenthesis are the contract required quantitation limits (CQRL)
NA: Not Applicable

TABLE 6-4
SUMMARY OF SURFACE WATER DATA
FOR TANK FARM 5

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)
INORGANICS			
Aluminium	1/1	(200)a	163
Antimony	0/1	22	NA
Arsenic	0/1	2	NA
Barium	1/1	(200)a	28.4
Beryllium	0/1	0.05	NA
Cadmium	1/1	(5)a	3.3
Calcium	1/1	(5000)a	36300
Chromium	0/1	1	NA
Cobalt	0/1	2	NA
Copper	0/1	2.5	NA
Cyanide	0/1	5	NA
Iron	1/1	(100)a	1900
Lead	0/1	1.5	NA
Magnesium	1/1	(5000)a	8200
Manganese	1/1	(15)a	304
Mercury	0/1	0.1	NA
Nickel	0/1	3.5	NA
Potassium	1/1	(5000)a	9550
Selenium	1/1	(5)a	2
Silver	0/1	1.5	NA
Sodium	1/1	(5000)a	10700
Thallium	0/1	4	NA
Vandium	0/1	4.6	NA
Zinc	1/1	(20)a	65.1
VOLATILES			
Chloromethane	0/1	10	NA
Bromomethane	0/1	10	NA
Vinyl chloride	0/1	10	NA
Chloroethane	0/1	10	NA
Methylene chloride	0/1	4	NA
Acetone	0/1	10	NA
Carbon disulfide	0/1	5	NA
1,1-Dichloroethene	0/1	5	NA
1,1-Dichloroethane	0/1	5	NA
1,2-Dichloroethene	0/1	5	NA
Chloroform	0/1	5	NA
1,2-Dichloroethane	0/1	5	NA
2-Butanone	0/1	NA	NA
1,1,1-Trichloroethane	0/1	5	NA
Carbon Tetrachloride	0/1	5	NA
Vinyl acetate	1/1	(10)a	10
Bromodichloromethane	0/1	5	NA
1,2-Dichloropropane	0/1	5	NA
1,3-Dichloropropene (Cis)	0/1	5	NA
Trichloroethene	0/1	5	NA
Dibromochloromethane	0/1	5	NA
1,1,2-Trichloroethane	0/1	5	NA
Benzene	0/1	5	NA
1,3-Dichloropropene (Trans)	0/1	5	NA
Bromoform	0/1	5	NA
4-Methyl-2-Pentanone	0/1	10	NA
2-Hexanone	0/1	10	NA
Tetrachloroethene	0/1	5	NA
1,1,2,2-Tetrachloroethane	0/1	5	NA
Toluene	0/1	5	NA
Chlorobenzene	0/1	5	NA
Ethylbenzene	0/1	5	NA
Styrene	0/1	5	NA
Xylenes	0/1	5	NA

a: SQLs in parenthesis are the contract required quantitation limits (CQRL)

TABLE 6-4 (cont.)
SUMMARY OF SURFACE WATER DATA
FOR TANK FARM 6

COMPOUND NAME	FREQUENCY OF DETECTION	RANGE OF SQL (µg/L)	RANGE OF DETECTION (µg/L)
SEMIVOLATILES			
Phenol	0.1	10	NA
Bis(2-chloroethyl) ether	0.1	10	NA
2-Chlorophenol	0.1	10	NA
1,3-Dichlorobenzene	0.1	10	NA
1,4-Dichlorobenzene	0.1	10	NA
Benzyl Alcohol	0.1	10	NA
1,2-Dichlorobenzene	0.1	10	NA
2-Methylphenol	0.1	10	NA
Bis(2-chloroisopropyl) ether	0.1	10	NA
4-Methylphenol	0.1	10	NA
N-nitroso-di-n-propylamine	0.1	10	NA
Hexachloroethane	0.1	10	NA
Nitrobenzene	0.1	10	NA
Isophorone	0.1	10	NA
2-Nitrophenol	0.1	10	NA
2,4-Dimethylphenol	0.1	10	NA
Benzoic acid	1.1	(50)a	50
Bis(2-chloroethoxy)methane	0.1	10	NA
2,4-Dichlorophenol	0.1	10	NA
1,2,4-Trichlorobenzene	0.1	10	NA
Naphthalene	0.1	10	NA
4-Chloroaniline	0.1	10	NA
Hexachlorobutadiene	0.1	10	NA
4-Chloro-3-methylphenol	0.1	10	NA
2-Methylnaphthalene	0.1	10	NA
Hexachlorocyclopentadiene	0.1	10	NA
2,4,6-Trichlorophenol	0.1	10	NA
2,4,5-Trichlorophenol	0.1	50	NA
2-Chloronaphthalene	0.1	10	NA
2-Nitroaniline	0.1	50	NA
Dimethylphthalate	0.1	10	NA
Acenaphthylene	0.1	10	NA
2,6-Dinitrotoluene	0.1	10	NA
3-Nitroaniline	0.1	50	NA
Acenaphthene	0.1	10	NA
2,4-Dinitrophenol	0.1	50	NA
4-Nitrophenol	0.1	50	NA
Dibenzofuran	0.1	10	NA
2,4-Dinitrotoluene	0.1	10	NA
Diethylphthalate	0.1	10	NA
4-Chlorophenyl-phenylether	0.1	10	NA
Fluorene	0.1	10	NA
4-Nitroaniline	0.1	50	NA
4,6-dinitro-2-methylphenol	0.1	50	NA
N-nitrosodiphenylamine	0.1	10	NA
4-Bromophenyl-phenylether	0.1	10	NA
Hexachlorobenzene	0.1	10	NA
Pentachlorophenol	0.1	50	NA
Phenanthrene	0.1	10	NA
Anthracene	0.1	10	NA
Di-n-butylphthalate	0.1	10	NA
Fluoranthene	0.1	10	NA
Pyrene	0.1	10	NA
Butylbenzylphthalate	0.1	10	NA
3,3'-Dichlorobenzidine	0.1	20	NA
Benzo(a)anthracene	0.1	10	NA
Chrysene	0.1	10	NA
Bis(2-ethylhexyl)phthalate	0.1	10	NA
Di-n-octylphthalate	0.1	10	NA
Benzo(b)fluoranthene	0.1	10	NA
Benzo(k)fluoranthene	0.1	10	NA
Benzo(a)pyrene	0.1	10	NA
Indeno(1,2,3-cd)pyrene	0.1	10	NA
Dibenzo(a,h)anthracene	0.1	10	NA
Benzo(ghi)perylene	0.1	10	NA
	0.1	10	NA
PESTICIDES			
4,4'-DDD	0.1		NA
4,4'-DDE	0.1		NA
4,4'-DDT	0.1		NA
Aldrin	0.1		NA
Alpha-BHC	0.1		NA
Alpha-chlorodane	0.1		NA
Beta-BHC	0.1		NA
Delrin	0.1		NA
Delta-BHC	0.1		NA
Endosulfan I	0.1		NA
Endosulfan II	0.1		NA
Endosulfan Sulfate	0.1		NA
Endrin	0.1		NA
Endrin ketone	0.1		NA
Gamma-BHC	0.1		NA
Gamma-chlorodane	0.1		NA
Heptachlor	0.1		NA
Heptachlor epoxide	0.1		NA
Methoxychlor	0.1		NA
Toxaphene	0.1		NA
PCB's			
Aroclor-1016	0.1	0.50	NA
Aroclor-1221	0.1	0.50	NA
Aroclor-1232	0.1	0.50	NA
Aroclor-1242	0.1	0.50	NA
Aroclor-1248	0.1	0.50	NA
Aroclor-1254	0.1	1.00	NA
Aroclor-1260	0.1	1.00	NA

a: SQLs in parenthesis are the contract required quantitation limits (CQRL)

TABLE 6-5
SUMMARY OF CONTAMINANTS
TANK FARM 5

COMPOUND NAME		RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (ug/L)	RANGE OF SEDIMENT SAMPLES (mg/kg)	RANGE OF SURFACE WATER SAMPLES (ug/L) a
INORGANICS						
Aluminum	&**	2730-9550	4750-15000	3900-190000	ND	183
Antimony	&*	5.3-5.4	7.7-10.1	ND	ND	ND
Arsenic	&***	6.6-10.1	7-31.3	21.4-266	ND	ND
Barium	&*	8.8-19.9	8.5-15.1	24-489	ND	28.4
Beryllium	&***	0.175-0.27	0.31-0.66	2.4-10.2	ND	ND
Cadmium	&*	ND	ND	5.0	ND	3.3
Calcium		322-854	842-2680	23000-89700	ND	36300
Chromium	&***	2.45-14	7.1-18.6	2.4-384	ND	ND
Cobalt	&***	2.4-15.1	7.7-42.5	22.8-296	ND	ND
Copper	&***	24.3-19.8	12.8-41	52.4-304	ND	ND
Cyanide		ND	ND	ND	ND	ND
Iron	&***	4480-25500	18000-80700	34700-787100	ND	1900
Lead	&***	5.1-56.6	2.7-13.9	13.4-530	ND	ND
Magnesium		772-2980	1300-5010	11700-108000	ND	8200
Manganese	&*	122-445	224-715	1240-10200	ND	304
Mercury	&*	2.0-54.0	ND	ND	ND	ND
Nickel	&***	18.5-21.0	18.1-43.8	78.9-530	ND	ND
Potassium		182-255	201	1790-9270	ND	9660
Selenium	&***	X 0.39	0.41	2-20	ND	2
Silver	&*	0.7	0.77-1.7	6.3-24.5	ND	ND
Sodium		ND	18.9	7540-32800	ND	10700
Thallium	&*	X 0.9	ND	4.0	ND	ND
Vanadium	&*	20.3-21.0	11-40.6	86.1-108	ND	ND
Zinc	&*	55.5-83	37.4-83.3	69.8-1630	ND	65.1
VOLATILES						
1,1-Dichloroethane	&***	ND	ND	4-23	ND	ND
1,1-Dichloroethene		ND	ND	ND	ND	ND
1,1,1-Trichloroethane	&*	X 0.006	ND	10-190	ND	ND
1,1,2-Trichloroethane	&*	X 0.006	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	&*	X 0.006	ND	ND	ND	ND
1,2-Dichloroethane		ND	ND	ND	ND	ND
1,2-Dichloroethene	&***	ND	ND	17-630	ND	ND
1,2-Dichloropropane	&*	X 0.006	ND	ND	ND	ND
1,3-Dichloropropene (Cis)	&*	X 0.006	ND	ND	ND	ND
1,3-Dichloropropene (Trans)	&*	X 0.006	ND	ND	ND	ND
2-Butanone		ND	ND	ND	ND	ND
2-Hexanone	X	0.012	ND	ND	ND	ND
4-Methyl-2-Pentanone	X	0.012	ND	ND	ND	ND
Acetone		ND	ND	ND	ND	ND
Benzene	&*	X 0.006	ND	ND	ND	ND
Bromodichloromethane	&*	X 0.006	ND	ND	ND	ND
Bromofom	&*	X 0.006	ND	ND	ND	ND
Bromomethane		ND	ND	ND	ND	ND
Carbon disulfide	X	0.006	ND	ND	ND	ND
Carbon Tetrachloride	&*	X 0.006	X 0.007	ND	ND	ND
Chlorobenzene	X	0.006	ND	ND	ND	ND
Chloroethane		ND	ND	ND	ND	ND
Chloroform	&*	ND	ND	3-7	ND	ND
Chloromethane		ND	ND	ND	ND	ND
Dibromochloromethane	&*	X 0.006	ND	ND	ND	ND
Ethylbenzene	&*	X 0.006	ND	47	ND	ND
Methylene chloride		ND	ND	ND	ND	ND
Styrene	&*	X 0.006	ND	ND	ND	ND
Tetrachloroethane	&***	0.002-0.006	0.001	7	ND	ND
Toluene	&*	0.002-0.006	0.003	38	ND	ND
Trichloroethane	&***	X 0.006	ND	4-36	ND	ND
Vinyl acetate	X	0.012	ND	ND	ND	10
Vinyl chloride		ND	ND	ND	ND	ND
Xylenes	&*	0.002-0.006	ND	100	ND	ND

& : Included as chemicals of potential concern for this site
 * : Risk addressed quantitatively only
 ** : Risk addressed qualitatively only
 *** : Risk addressed both quantitatively and qualitatively
 X : Values "UU" qualified data only
 ND : Not Detected

TABLE 8-5 (cont.)
SUMMARY OF CONTAMINANTS
TANK FARM 5

COMPOUND NAME	RANGE OF SURFACE SOIL SAMPLES (mg/kg)	RANGE OF SUBSURFACE SOIL SAMPLES (mg/kg)	RANGE OF GROUND WATER SAMPLES (ug/L)	RANGE OF SEDIMENT SAMPLES (mg/kg)	RANGE OF SURFACE WATER SAMPLES (ug/L) a
SEMIVOLATILES					
1,2-Dichlorobenzene	X 0.41	X 0.37-0.43	X 10	ND	ND
1,2,4-Trichlorobenzene	X 0.41	X 0.37-0.43	X 10	ND	ND
1,3-Dichlorobenzene	X 0.41	X 0.37-0.43	X 10	ND	ND
1,4-Dichlorobenzene	&***	X 0.37-0.43	X 10	ND	ND
2-Chloronaphthalene	X 0.41	X 0.37-0.43	X 10	ND	ND
2-Chlorophenol	X 0.41	X 0.37-0.43	ND	ND	ND
2-Methylnaphthalene	&***	X 0.37-0.43	10-71	ND	ND
2-Methylphenol	X 0.41	X 0.37-0.43	ND	ND	ND
2-Nitroaniline	X 2.0-2.1	X 1.9-2.2	X 50	ND	ND
2-Nitrophenol	X 0.41	X 0.37-0.43	ND	ND	ND
2,4-Dichlorophenol	X 0.41	X 0.37-0.43	ND	ND	ND
2,4-Dimethylphenol	X 0.41	X 0.37-0.43	ND	ND	ND
2,4-Dinitrophenol	X 2.0	X 1.9-2.2	ND	ND	ND
2,4-Dinitrotoluene	&*	X 0.37-0.43	X 10	ND	ND
2,4,6-Trichlorophenol	X 2.0	X 1.9-2.2	ND	ND	ND
2,4,6-Trichlorophenol	X 0.41	X 0.37-0.43	ND	ND	ND
2,6-Dinitrotoluene	&*	X 0.37-0.43	X 10	ND	ND
3-Nitroaniline	X 2.0-2.05	X 1.9-2.2	X 10	ND	ND
3,3'-Dichlorobenzidine	&*	X 0.75-0.87	X 20	ND	ND
4-Bromophenyl-phenylether	X 0.41	X 0.37-0.43	X 10	ND	ND
4-Chloro-3-methylphenol	X 0.41	X 0.37-0.43	ND	ND	ND
4-Chloroaniline	X 0.41	X 0.37-0.43	X 10	ND	ND
4-Chlorophenyl-phenylether	X 0.41	X 0.37-0.43	X 10	ND	ND
4-Methylphenol	X 0.41	X 0.37-0.43	ND	ND	ND
4-Nitroaniline	X 2.0-2.05	X 1.9-2.2	X 50	ND	ND
4-Nitrophenol	X 2.0	X 1.9-2.2	ND	ND	ND
4,6-dinitro-2-methylphenol	X 2.0	X 1.9-2.2	ND	ND	ND
Acenaphthene	X 0.41	X 0.37-0.43	X 10	ND	ND
Acenaphthylene	X 0.41	X 0.37-0.43	X 10	ND	ND
Anthracene	&***	0.045-0.41	X 10	ND	ND
Benzoic acid	&***	X 2.0-2.2	0.095-2.2	ND	X 50
Benzo(a)anthracene	&***	0.084-0.41	X 0.37-0.43	X 10	ND
Benzo(a)pyrene	&***	0.069-0.41	X 0.37-0.43	X 10	ND
Benzo(b)fluoranthene	&***	0.14-0.41	X 0.37-0.43	X 10	ND
Benzo(g,h,i)perylene	X 0.41	X 0.37-0.43	X 10	ND	ND
Benzo(k)fluoranthene	&***	0.07-0.41	X 0.37-0.43	X 10	ND
Benzyl Alcohol	X 0.41	X 0.37-0.43	X 10	ND	ND
Bis(2-chloroethoxy)methane	X 0.41	X 0.37-0.43	X 10	ND	ND
Bis(2-chloroethyl)ether	&*	X 0.37-0.43	X 10	ND	ND
Bis(2-chloroisopropyl)ether	X 0.41	X 0.37-0.43	X 10	ND	ND
Bis(2-ethylhexyl)phthalate	&*	0.071-0.41	0.43	X 10	ND
Butylbenzylphthalate	&***	X 0.41	X 0.43-2.0	X 10	ND
Chrysene	&***	0.05-0.41	X 0.37-0.43	X 10	ND
Dibenzofuran	X 0.41	X 0.37-0.43	X 10	ND	ND
Dibenzo(a,h)anthracene	&***	X 0.41	X 0.37-0.43	X 10	ND
Diethylphthalate	X 0.41	X 0.37-0.43	X 10	ND	ND
Dimethylphthalate	X 0.41	X 0.37-0.43	X 10	ND	ND
Di-n-butylphthalate	&*	0.046-0.41	0.12-2.6	X 10	ND
Di-n-octylphthalate	X 0.41	X 0.37-0.43	X 10	ND	ND
Fluoranthene	&***	0.18-0.41	X 0.37-0.43	X 10	ND
Fluorene	&***	X 0.41	X 0.37-0.43	10-45	ND
Hexachlorobenzene	&*	X 0.41	X 0.37-0.43	X 10	ND
Hexachlorobutadiene	&*	X 0.41	X 0.37-0.43	X 10	ND
Hexachlorocyclopentadiene	X 0.41	X 0.37-0.43	X 10	ND	ND
Hexachloroethane	&*	X 0.41	X 0.37-0.43	X 10	ND
Indeno(1,2,3cd)pyrene	&***	X 0.41	X 0.37-0.43	X 10	ND
Isophorone	&*	X 0.41	X 0.37-0.43	10	ND
Naphthalene	&***	X 0.41	X 0.37-0.43	10-27	ND
Nitrobenzene	X 0.41	X 0.37-0.43	X 10	ND	ND
N-nitroso-di-n-propylamine	&*	X 0.41	X 0.37-0.43	X 10	ND
N-nitrosodiphenylamine	&*	X 0.41	X 0.37-0.43	X 10	ND
Pentachlorophenol	&*	X 2.0	X 1.9-2.2	ND	ND
Phenanthrene	&***	0.072-0.41	X 0.37-0.43	10-42	ND
Phenol	X 0.41	X 0.37-0.43	ND	ND	ND
Pyrene	&***	X 0.41	X 0.37-0.43	10-21	ND
PESTICIDES					
4,4'-DDD	ND	ND	ND	ND	ND
4,4'-DDE	&***	0.025-0.032	0.0036	ND	ND
4,4'-DDT	&***	0.031-0.074	0.017	ND	ND
Aldrin	ND	ND	ND	ND	ND
Alpha-BHC	ND	ND	ND	ND	ND
Alpha-chlordane	ND	ND	ND	ND	ND
Beta-BHC	ND	ND	ND	ND	ND
Deildrin	ND	ND	ND	ND	ND
Delta-BHC	ND	ND	ND	ND	ND
Endosulfen I	ND	ND	ND	ND	ND
Endosulfen II	ND	ND	ND	ND	ND
Endosulfen Sulfate	ND	ND	ND	ND	ND
Endrin	ND	ND	ND	ND	ND
Endrin ketone	ND	ND	ND	ND	ND
Gamma-BHC	ND	ND	ND	ND	ND
Gamma-chlordane	ND	ND	ND	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	ND	ND
Methoxychlor	ND	ND	ND	ND	ND
Toxaphene	ND	ND	ND	ND	ND
PCB's					
Aroclor-1016	ND	ND	ND	ND	ND
Aroclor-1221	ND	ND	ND	ND	ND
Aroclor-1232	ND	ND	ND	ND	ND
Aroclor-1242	ND	ND	ND	ND	ND
Aroclor-1248	ND	ND	ND	ND	ND
Aroclor-1254	ND	ND	ND	ND	ND
Aroclor-1260	ND	ND	ND	ND	ND

& : Included as chemicals of potential concern for this site
* : Risk addressed quantitatively only
** : Risk addressed qualitatively only
*** : Risk addressed both quantitatively and qualitatively
X : Values "U" qualified data only
ND : Not Detected

TABLE 6-6
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE -- TANK FARM FIVE

PARAMETER	VALUE OR RANGE	VALUE USED	RATIONALE	REFERENCE
Global variables				
Body Weight (kg)				
Children				
- scenario 1	25-61.2	49.2	Value based on average of males and females between 6-18 yrs	EPA 1991
- scenario 4	11.6-17.4	14.5	Value based on average of males and females between 0-6 yrs	EPA 1991
Adult	67.2-74.5	70	Value based on adult body weight	EPA 1991
Exposure Duration (years)				
- scenario 1 (children)	1-18	9	Based upon the age range of children with access to site	
- scenario 1 (adults)	1-52	30	National upper-bound (90th percentile) at one residence	
- scenario 2 (adults)	1-52	25	National upper-bound (90th percentile) at one job.	EPA 1991
- scenario 3 (adults)	1-52	1	Amount of time spent building an industrial facility.	EPA 1991
- scenario 4 (children)	1-18	6	Duration for most exposed group (0-6 yr old)	EPA 1991
- scenario 4 (adult)	1-52	30	National upper-bound (90th percentile) at one residence	EPA 1991
Averaging Time				
Cancer-risks (days)	NA	25,550	Value based upon 70 year life expectancy.	EPA 1989
Noncancer-risks (days)				
- scenario 1 (children)	365-6570	3285	Value based upon exposure duration.	
- scenario 1 (adults)	365-18980	10950	Value based upon exposure duration.	
- scenario 2 (adults)	250-18980	9125	Value based upon exposure duration.	
- scenario 3 (adults)	250-18980	250	Value based upon exposure duration.	
- scenario 4 (children)	365-6570	2190	Value based upon exposure duration.	
- scenario 4 (adults)	365-18980	10950	Value based upon exposure duration.	
Dermal Soil Contact Rate (mg/day)	500-1000	500	Adherence=0.5mg/cm ² ; skin s.a.=2000cm ² ; fraction exposed=50%	EPA 1989a
Absorption Factor				
- Dermal:				
VOC's	0-1	0.5		EPA 1989a
PAHs/PCBs	0-1	0.05		EPA 1989a
Inorganics	0-1	negligible		EPA 1989a
Pesticides	0-1	0.05, 0.5	High; Low soil sorption, respectively	EPA 1989a
- Ingestion:				
VOC's, PAHs	0-1	1		EPA 1989a
Inorganics	0-1	1		EPA 1989a
Pesticides	0-1	0.3; 1	High; Low soil sorption, respectively	EPA 1989a
Lead	0-1	0.5; 0.3	Children; Adults, respectively	EPA 1989a
- Inhalation:	0-1	1	Complete absorption assumed	EPA 1989a
Permeability Constant - Dermal contact in Water (cm/hr)		8.4E-04	Based upon the penetration rate of water	EPA 1989
Chemical Concentration Justification			Geometric mean and maximum values used in exposure estimates	
Surface Soils; Subsurface soils; Ground Water			were calculated using the methods described in text.	

TABLE 6-6
(continued)
SUMMARY OF PARAMETER VALUES USED TO ESTIMATE EXPOSURE – TANK FARM FIVE

Scenario 1 – Current Use: Trespassing					
Exposure Frequency (days/year)	1–365	350	Daily entry on site with 2 weeks away from area.		
Ingestion Of Chemicals In Soils					EPA 1989a
Ingestion Rate (mg/day) (children)	0–200	100	Soil ingestion rate for those under 6 years of age.		
Ingestion Rate (mg/day) (adults)	0–480	100	Typical soil ingestion rate for adults.		
Contact With Surface Water					
Exposure Frequency (days/year)	1–365	150	Daily surface water contact during warm months only.		
Surface Area (children)	0–13130	7505	Feet, legs, arms, and hands getting wet.		
Surface Area (adults)	0–18150	5673	Feet, lower legs, forearms, and hands getting wet.		
Scenario 2 – Current Use: Industrial Exposure					
Exposure Frequency (days/year)	1–365	250	Based on an estimate of the number of workdays in one year.		EPA 1991
Ingestion Of Chemicals In Drinking Water					
Ingestion Rate (L/day)	0–2	1	Water ingestion rate for a commercial setting.		EPA 1991
Ingestion Of Chemicals In Soils					
Ingestion Rate (mg/day)	0–480	50	Soil ingestion rate for a commercial setting.		EPA 1991
Scenario 3 – Future Use: Construction					
Exposure Frequency (days/year)	1–365	250	Based upon one year to construct an industrial facility.		
Ingestion Of Chemicals In Soils					
Ingestion Rate (mg/day)	0–480	480	Soil ingestion rate for construction work.		EPA 1991
Inhalation Of Airborne Chemicals Absorbed to Dust					
Inhalation Rate (m3/workshift)	5.0–30	20	Adults during moderate exertion		EPA 1991
Scenario 4 – Future Use: Residential Scenario					
Exposure Frequency (days/yr)	1–365	350	Two weeks spent away from home.		EPA 1991
Ingestion Of Chemicals In Soils and House Dust					
Ingestion Rate (mg/day)					
Child	0–200	200	Children, 1–6 years old		EPA 1991
Adult	0–480	100	Typical ingestion rate for adults.		EPA 1991
Ingestion Of Chemicals In Drinking Water					
Ingestion Rate (L/day)					
Child		0.750	Children, 0–6 years old		EPA 1990
Adult		2	Adult, 90th percentile		EPA 1989
Inhalation Of Airborne (Vapor Phase) Chemicals					
Inhalation Rate (m3/hr)	0.7–6	0.625	Adults and children, light activity assumed.		EPA 1990
Exposure Time (hrs/day)	0.1–0.2	0.2 hr	Based upon the duration of a shower.		EPA 1990
Inhalation Of Airborne Chemicals Absorbed to Dust					
Inhalation Rate (m3/hr)	0.7–6	0.83	Adults and children, light activity assumed.		EPA 1990
Exposure Time (hr/day)	1–24	24	Outdoor and indoor dust exposure.		EPA 1990

TABLE 6-7
SCENARIO 1
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FIVE

	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK	
	2.4E-07	7.4E-06	CHILD MEAN
	5.7E-07	1.7E-05	ADULT MEAN
	3.3E-07	1.5E-05	CHILD MAX
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	7.8E-07	3.4E-05	ADULT MAX
	7.2E-06		CHILD MEAN
	1.7E-05		ADULT MEAN
	1.4E-05		CHILD MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	3.3E-05		ADULT MAXIMUM
	NA		CHILD
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SURFACE WATER	NA		ADULT
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SURFACE WATER	NA		CHILD

[illegible]

TABLE 6-9
SCENARIO 2
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FIVE

	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	3.4E-07	5.4E-06	MEAN
	4.6E-07	1.0E-05	MAX
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	5.0E-06		MEAN
	1.0E-05		MAXIMUM

TABLE 6-10
SCENARIO 2
SUMMARY OF CHRONIC HAZARD INDEX RATIOS
TANK FARM FIVE

	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE (HI)	
	4.8E-04	1.4E-02	MEAN
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	7.2E-04	1.1E-01	MAXIMUM
	1.4E-02		MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	1.1E-01		MAXIMUM

TABLE 6-11
SCENARIO 3
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FIVE

	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK	
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	1.0E-08	3.5E-06	MEAN
	1.9E-08	6.5E-06	MAX
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	3.5E-06	MEAN	
	6.5E-06	MAXIMUM	
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	1.3E-08	MEAN	
	2.4E-08	MAXIMUM	

TABLE 6-12
SCENARIO 3
SUMMARY OF HAZARD INDEX RATIOS
TANK FARM FIVE

	PATHWAY HAZARD INDEX (HI)	TOTAL EXPOSURE (HI)	
	1.5E-04	2.0E-01	MEAN
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL	2.6E-04	3.6E-01	MAX
	2.0E-01		MEAN
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL	3.6E-01		MAXIMUM
	3.2E-03		MEAN
EXPOSURE PATHWAY: INHALATION OF CHEMICALS ABSORBED TO DUST	5.2E-03		MAXIMUM

TABLE 6-13
SCENARIO 4
SUMMARY OF CANCER RISK ESTIMATES
TANK FARM FIVE

COMPOUND NAME	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX. (mg/kg/day)	CDI ADULT MAX. (mg/kg/day)	CDI ADJUSTED FOR ABSORPTION	SF (mg/kg/day)-1	WEIGHT OF EVIDENCE	TYPE OF CANCER	SF BASIS/ SOURCE	CHEM. RISK CHILD MEAN	CHEM. RISK ADULT MEAN	CHEM. RISK CHILD MAX.	CHEM. RISK ADULT MAX.	TOTAL PATHWAY RISK	TOTAL EXPOSURE RISK		
															3.4E-03	3.4E-03	CHILD MEAN
															9.3E-03	9.3E-03	ADULT MEAN
															6.1E-03	6.2E-03	CHILD MAXIMUM
															1.7E-02	1.7E-02	ADULT MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER																	
INORGANICS																	
Arsenic	3.1E-04	8.6E-04	1.1E-03	3.1E-03	No	1.75E+00	A	Skin	Water/IRIS	5.5E-04	1.5E-03	2.0E-03	5.4E-03				
Beryllium	1.5E-05	4.0E-05	4.4E-05	1.2E-04	No	4.30E+00	B2	Gross tumors, all sites	Water/IRIS	6.3E-05	1.7E-04	1.9E-04	5.1E-04				
SEMI-VOLATILES																	
1,3-Dichlorobenzidine	8.0E-05	1.6E-04	8.8E-05	2.3E-04	No	4.50E+01	B2	Mammary adenocarcinomas	Water/IRIS	2.7E-05	7.4E-05	3.9E-05	1.1E-04				
Benzo(a)anthracene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Liver, lung, skin	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Benzo(a)pyrene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Stomach, lung	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Benzo(b)fluoranthene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, thorax, skin	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Benzo(k)fluoranthene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, thorax, skin	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Bis(2-chloroethyl)ether	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.10E+00	B2	Liver	IRIS	3.3E-05	9.0E-05	4.7E-05	1.3E-04				
Chrysene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Malignant lymphoma	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Dibenzo(a,h)anthracene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, mammary	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
Hexachlorobenzene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.60E+00	B2	Hepatocellular carcinomas	Diet/IRIS	4.8E-05	1.3E-04	6.9E-05	1.9E-04				
Indeno(1,23cd)pyrene	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	1.15E+01	B2	Lung, skin	IRIS	3.4E-04	9.4E-04	4.9E-04	1.4E-03				
N-nitroso-di-n-propylamine	3.0E-05	8.2E-05	4.3E-05	1.2E-04	No	7.00E+00	B2	Hepatocellular carcinomas	Water/IRIS	2.1E-04	5.7E-04	3.0E-04	8.3E-04				
															5.5E-07		CHILD MEAN
															5.7E-07		ADULT MEAN
															5.6E-07		CHILD MAXIMUM
															5.7E-07		ADULT MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL																	
															3.3E-06		CHILD MEAN
															1.7E-06		ADULT MEAN
															6.5E-06		CHILD MAXIMUM
															3.3E-06		ADULT MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																	
															7.8E-07		CHILD MEAN
															8.1E-07		ADULT MEAN
															2.6E-06		CHILD MAXIMUM
															2.7E-06		ADULT MAXIMUM
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																	
															1.6E-08		CHILD MEAN
															1.6E-08		ADULT MEAN
															4.7E-08		CHILD MAXIMUM
															4.9E-08		ADULT MAXIMUM
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																	

SUMMARY OF CHRONIC HAZARD INDEX ESTIMATES TANK FARM FIVE

COMPOUND NAME	CDI CHILD MEAN (mg/kg/day)	CDI ADULT MEAN (mg/kg/day)	CDI CHILD MAX. (mg/kg/day)	CDI ADULT MAX. (mg/kg/day)	CDI ADJ. FOR ABS.	RFD (mg/kg/day)	CON. LEVEL	CRITICAL EFFECT	RFD SOURCE/ BASIS	UNCERT. ADJ.	MF	HAZ.Q.UO. CHILD MEAN	HAZ.Q.UO. ADULT MEAN	HAZ.Q.UO. CHILD MAXIMUM	HAZ.Q.UO. ADULT MAXIMUM	PATHWAY HAZARD INDEX (H)	TOTAL EXPOSURE (H)		
																	1.3E+01	1.3E+01	CHILD MEAN
																	7.1E+00	7.1E+00	ADULT MEAN
																	3.6E+01	3.6E+01	CHILD MAXIMUM
																	2.0E+01	2.0E+01	ADULT MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN DRINKING WATER																			
INORGANICS																			
Arsenic	3.6E-03	2.0E-03	1.3E-02	7.3E-03	No	1E-03	Low Medium	Keratosis and hyperpigmentation	Oral/HEAST	1000	1	3.6E+00	2.0E+00	1.3E+01	7.3E+00				
Chromium	4.4E-03	2.4E-03	1.9E-02	1.1E-02	No	5E-03		None observed	Water/IRIS, HEAST	500	1	8.8E-01	4.8E-01	3.8E+00	2.1E+00				
Manganese	2.7E-01	1.5E-01	5.1E-01	2.8E-01	No	1E-01		CNS effects	Diet/IRIS, HEAST	1	1	2.7E+00	1.5E+00	5.1E+00	2.8E+00				
Thallium	2.0E-04	1.1E-04	2.0E-04	1.1E-04	No	7E-06		Increased SGOT and LDH levels, alopecia	Diet/HEAST	3000		2.9E+00	1.6E+00	2.9E+00	1.6E+00				
VOLATILES																			
1,2-Dichloroethene	2.9E-04	1.6E-04	3.1E-02	1.7E-02	No	1E-02		Decreased hematocrit and hemoglobin	Gavage/HEAST	3000		2.9E-02	1.6E-02	3.1E+00	1.7E+00				
																	3.2E-03		CHILD MEAN
																	6.7E-04		ADULT MEAN
																	3.2E-03		CHILD MAXIMUM
																	6.7E-04		ADULT MAXIMUM
EXPOSURE PATHWAY: DERMAL CONTACT WITH CHEMICALS IN SOIL																			
																	3.7E-01		CHLD MEAN
																	3.6E-02		ADULT MEAN
																	3.1E+00		CHILD MAXIMUM
																	3.2E-01		ADULT MAXIMUM
EXPOSURE PATHWAY: INGESTION OF CHEMICALS IN SOIL AND HOUSE DUST																			
																	2.7E-03		CHILD MEAN
																	5.6E-04		ADULT MEAN
																	5.4E-02		CHILD MAXIMUM
																	1.1E-02		ADULT MAXIMUM
EXPOSURE PATHWAY: INHALATION OF AIRBORNE (VAPOR PHASE) CHEMICALS																			
																	1.2E-03		CHILD MEAN
																	2.5E-04		ADULT MEAN
																	5.2E-03		CHILD MAXIMUM
																	1.1E-03		ADULT MAXIMUM
EXPOSURE PATHWAY: INHALATION OF AIRBORNE CHEMICALS ADSORBED TO DUST																			

TABLE 6-15
SUMMARY OF EXPOSURE PATHWAYS
TANK FARM FIVE

Potentially Exposed Population	Exposure Route, Medium and Exposure Point	Pathway Selected for Evaluation?	Reason for Selection or Inclusion
Current Land Use			
Children	Ingestion of ground water	No	Recreational use of site: Potable supply not ground water
Children	Ingestion of soils on site	Yes	Access to site possible
Children	Ingestion of sediments on site	No	Soils data includes contamination near shore
Children	Ingestion of surface water on site	No	Access to standing water in burn pit possible
Children	Dermal contact with soils	Yes	Access to site possible
Children	Dermal contact with sediments	No	Soils data includes contamination near shore
Children	Inhalation of fugitive dusts	No	Site vegetated
Children	Dermal contact with surface water	Yes	Access to standing water in burn pit possible
Firefighter Trainees	Ingestion of ground water from local wells	No	No potable supply from ground water
Firefighter Trainees	Ingestion of soils on site	Yes	Incidental ingestion expected
Firefighter Trainees	Ingestion of sediments on site	No	Contact route unlikely
Firefighter Trainees	Ingestion of surface water on site	No	Contact route unlikely
Firefighter Trainees	Dermal contact with soils	Yes	Contact with soils may occur during work hours
Firefighter Trainees	Dermal contact with sediments	No	Contact route unlikely
Firefighter Trainees	Inhalation of fugitive dusts	No	Generation of fugitive dust not expected (Site vegetated or paved)
Future Land Use			
Residents	Ingestion of ground water from local wells on the site	Yes	Potential residential use of site
Residents	Ingestion of soils on site	Yes	Potential residential use of site
Residents	Ingestion of sediments on site	No	Soils data includes contamination near shore
Residents	Ingestion of surface water on site	No	Pathway modeled in current use and is of minor importance compared to groundwater ingestion.
Residents	Dermal contact with soils	Yes	Potential residential use of site
Residents	Dermal contact with sediments	No	Soils data includes contamination near shore
Residents	Inhalation of fugitive dusts	Yes	Potential residential use of site may produce areas devoid of cover
Residents	Inhalation of chemicals volatilized from ground water during home use	Yes	Potential residential use of site; volatile organics in ground water
Construction Workers	Ingestion of ground water from local wells	No	Wells not developed during construction
Construction Workers	Ingestion of soils on site	Yes	Incidental ingestion expected
Construction Workers	Ingestion of sediments on site	No	Soils data includes contamination near shore
Construction Workers	Ingestion of surface water on site	No	Contact route unlikely
Construction Workers	Dermal contact with soils	Yes	Contact with soils expected during construction
Construction Workers	Dermal contact with sediments	No	Contact route unlikely
Construction Workers	Inhalation of fugitive dusts	Yes	Generation of fugitive dust expected during construction

Figure 2-1

Blood Lead Distribution in 0-6 Year Old
Children at McAllister Point

(Geometric Mean Soil Lead For The Entire Site)

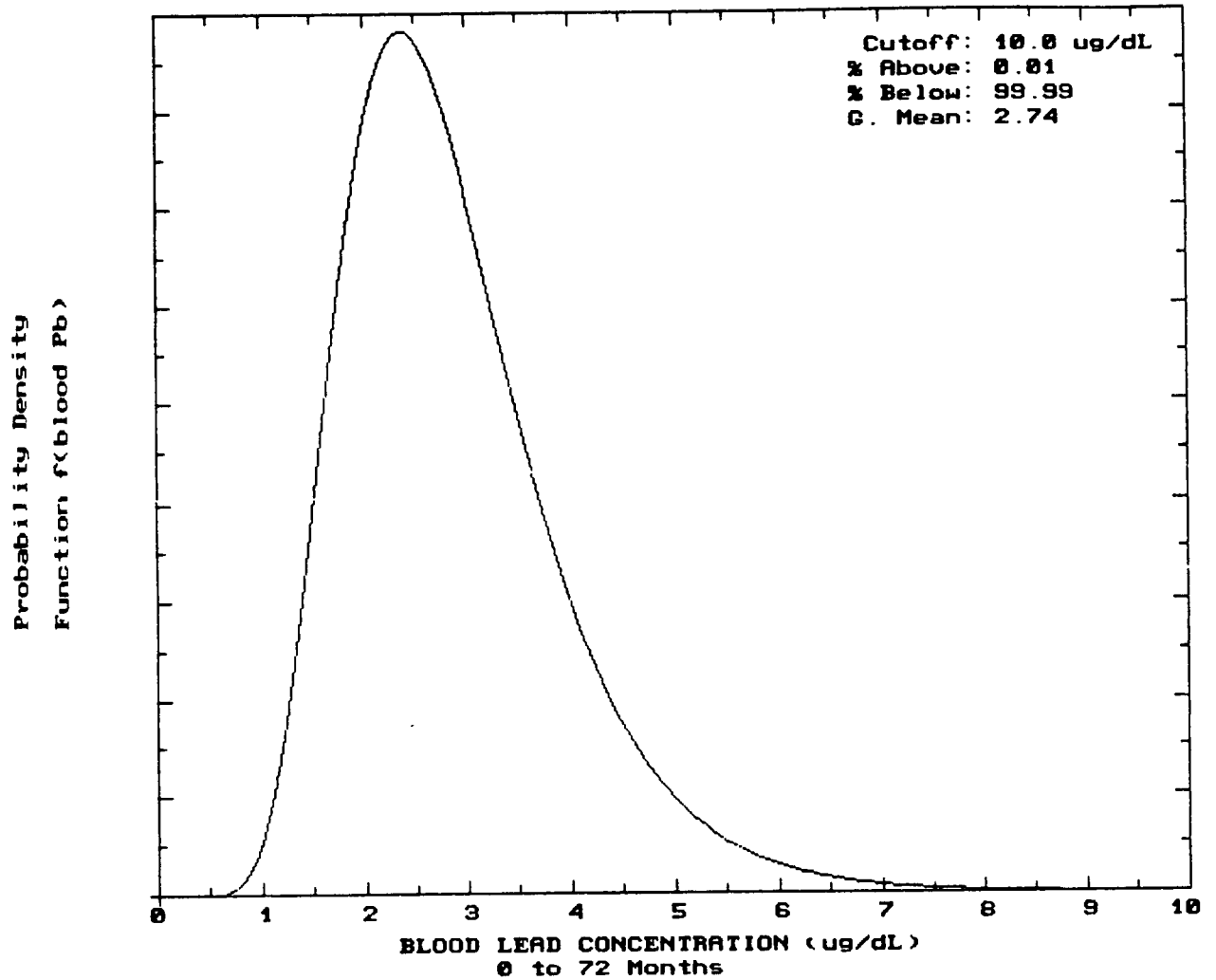


Figure 2-2

Blood Lead Distribution in 0-6 Year Old
Children at McAllister Point

(Geometric Mean Soil Lead For The "Impacted" Zone)

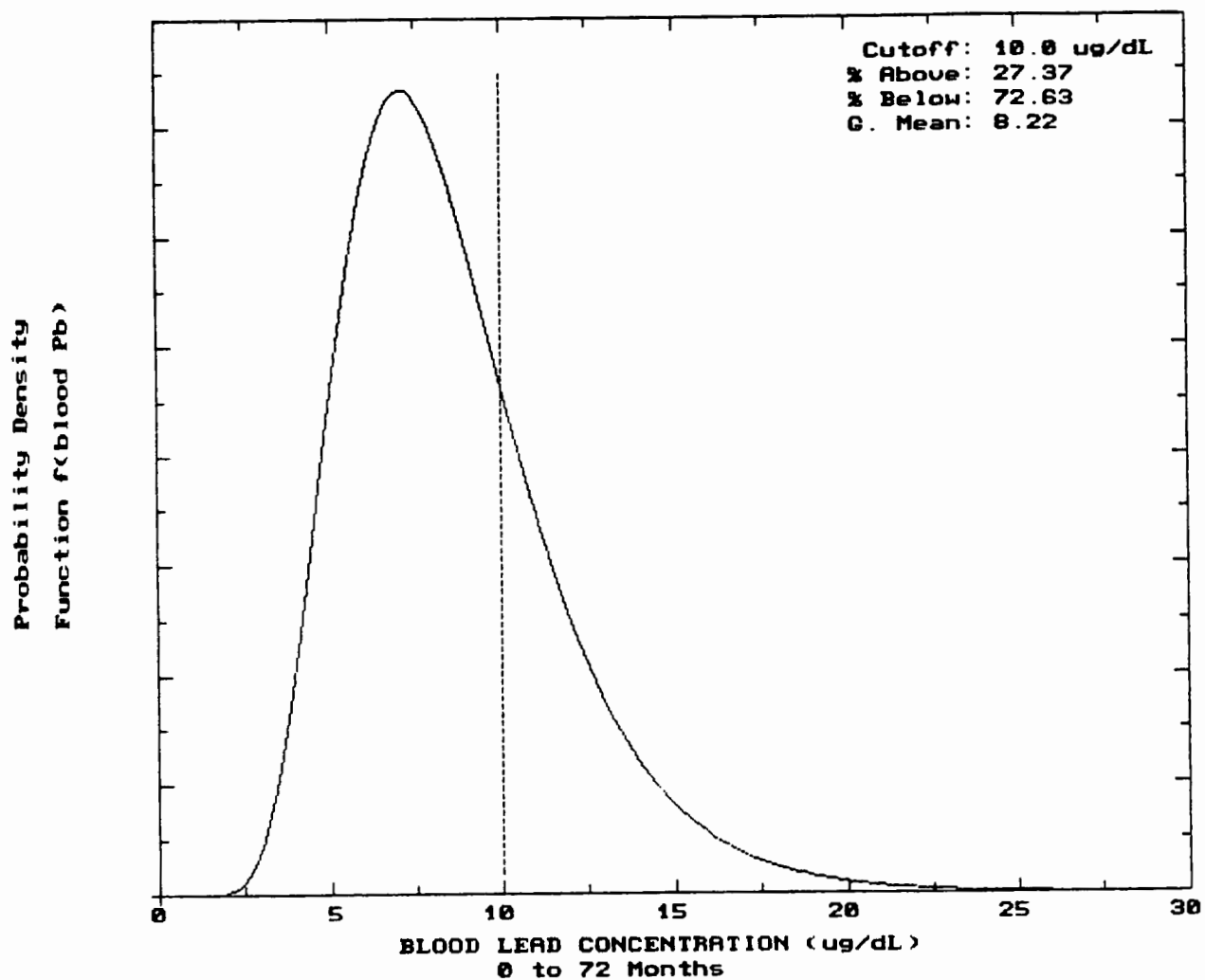


Figure 2-3

Blood Lead Distribution in 0-6 Year Old
Children at McAllister Point

(Maximum Soil Lead For The Entire Site)

